PROPOSED
TOTAL MAXIMUM DAILY LOAD (TMDL)

for

E. Coli

in the

Pine Creek Subwatershed

of the

South Fork Cumberland Watershed (HUC 05130104)

Scott County, Tennessee

FINAL

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Submitted January 20, 2006
Approved by EPA Region 4 – February 27, 2006

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LIST OF ABBREVIATIONS

ADB	Assessment Database
AFO	Animal Feeding Operation
BMP	Best Management Practices
BST	Bacteria Source Tracking
CAFO	Concentrated Animal Feeding Operation
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
DEM	Digital Elevation Model
DMR	Discharge Monitoring Report
DWPC	Division of Water Pollution Control
E. coli	Escherichia coli
EPA	Environmental Protection Agency
GIS	Geographic Information System
HSPF	Hydrological Simulation Program - Fortran
HUC	Hydrologic Unit Code
LA	Load Allocation
LDC	Load Duration Curve
LSPC	Loading Simulation Program in C^{++}
MGD	Million Gallons per Day
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characteristic
MS4	Municipal Separate Storm Sewer System
MST	Microbial Source Tracking
NHD	National Hydrography Dataset
NMP	Nutrient Management Plan
NOV	Notice of Violation
NPS	Nonpoint Source
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PCR	Polymerase Chain Reaction
PDFE	Percent of Days Flow Exceeded
PFGE	Pulsed Field Gel Electrophoresis
Rf3	Reach File v.3
RM	River Mile
SSO	Sanitary Sewer Overflow
STP	Sewage Treatment Plant
SWMP	Storm Water Management Program
TDA	Tennessee Department of Agriculture
TDEC	Tennessee Department of Environment & Conservation
TDOT	Tennessee Department of Transportation
TMDL	Total Maximum Daily Load
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
USGS	United States Geological Survey
UCF	Unit Conversion Factor
WCS	Watershed Characterization System
WLA	Waste Load Allocation
WWTF	Wastewater Treatment Facility

SUMMARY SHEET

Total Maximum Daily Load for E. coli in South Fork Cumberland Watershed (HUC 05130104)

Impaired Waterbody Information

State: Tennessee
Counties: Scott
Watershed: Pine Creek Subwatershed of South Fork Cumberland (HUC 05130104)
Constituents of Concern: E. coli

Impaired Waterbodies Addressed in This Document:

Waterbody ID	Waterbody	Miles Impaired
TN05130104048 – 0200	NORTH FORK PINE CREEK	15
TN05130104048 – 0300	LITTON FORK PINE CREEK	2.5
TN05130104048 – 0400	EAST FORK PINE CREEK	2.8
TN05130104048 – 0410	UNNAMED TRIB TO PINE CREEK	2.4
TN05130104048 – 0500	SOUTH FORK PINE CREEK	1.7
TN05130104048 – 1000	PINE CREEK	3.2
TN05130104048 – 2000	PINE CREEK	4.1
TN05130104048 – 3000	PINE CREEK	3.0

Designated Uses:

The designated use classifications for waterbodies in the Pine Creek Subwatershed include fish and aquatic life, irrigation, livestock watering & wildlife, and recreation. Portions of Pine Creek (Mile 10.5 to origin) are also designated for domestic water supply.

Water Quality Goal:

Derived from *State of Tennessee Water Quality Standards, Chapter 1200-4-3, General Water Quality Criteria, January, 2004* for recreation use classification (most stringent):

The concentration of the E. coli group shall not exceed 126 colony forming units per 100 mL, as a geometric mean based on a minimum of 5 samples collected from a given sampling site over a period of not more than 30 consecutive days with individual samples being collected at intervals of not less than 12 hours. For the purposes of determining the geometric mean, individual samples having an E. coli concentration of less than 1 per 100 mL shall be considered as having a concentration of 1 per 100 mL. In addition, the concentration of the E. coli group in any individual sample taken from a lake, reservoir, State Scenic River, or Tier II or III stream (1200-4-3-.06) shall not exceed 487 colony forming units per 100 mL. The concentration of the E. coli group in any individual sample taken from any other waterbody shall not exceed 941 colony forming units per 100 mL.

TMDL Scope:

Waterbodies identified on the Final 2004 303(d) list as impaired due to E. coli. TMDLs are generally developed for impaired waterbodies on a HUC-12 basis.

Analysis/Methodology:

The TMDLs for impaired waterbodies in the Pine Creek Subwatershed were developed using the load duration curve methodology to assure compliance with the E. Coli 126 counts/100 mL geometric mean and 941 counts/100 mL maximum standards. A duration curve is a cumulative frequency graph that represents the percentage of time during which the value of a given parameter is equaled or exceeded. Load duration curves are developed from flow duration curves and can illustrate existing water quality conditions (as represented by loads calculated from monitoring data), how these conditions compare to desired targets, and the portion of the waterbody flow regime represented by these existing loads. Load duration curves were used to determine the load reductions required to meet the target maximum concentrations for E. coli (standard - MOS). When sufficient data were available, load reductions were also determined based on geometric mean criteria.

Critical Conditions:

Water quality data collected over a period of 10 years for load duration curve analysis were used to assess the water quality standards representing a range of hydrologic and meteorological conditions.

Seasonal Variation:

The 10-year period used for LSPC model simulation period and for load duration curve analysis included all seasons and a full range of flow and meteorological conditions.

Margin of Safety (MOS):

Explicit – 10% of the water quality standard for each impaired subwatershed.

Summary of TMDLs, WLAs, & LAs for Impaired Waterbodies

HUC-12 Subwatershed (05130104__) or Drainage Area	Impaired Waterbody Name	Impaired Waterbody ID	TMDL	WLAs				LAs	
				WWTFs[a] (Monthly Avg.) E. Coli	Leaking Collection Systems[b]	CAFOs	MS4s[c]	Precipitation Induced Nonpoint Sources	Other Direct Sources[d]
			[% Red.]	[cts./day]	[cts./day]	[cts./day]	[% Red.]	[% Red.]	[cts./day]
0402	North Fork Pine Creek	TN05130104048 – 0200	**97.3**	**NA***	**NA**	**NA**	**NA**	**97.3**	**0**
	Litton Fork Pine Creek	TN05130104048 – 0300	**>88.2**	**NA***	**NA**	**NA**	**NA**	**>88.2**	**0**
	East Fork Pine Creek	TN05130104048 – 0400	**>80.0**	**NA***	**NA**	**NA**	**NA**	**>80.0**	**0**
	Unnamed Trib to Pine Creek	TN05130104048 – 0410							
	South Fork Pine Creek	TN05130104048 – 0500							
	Pine Creek	TN05130104048 – 1000	**96.4**	**4.674×10^9**	**0**	**NA**	**NA**	**96.4**	**0**
	Pine Creek	TN05130104048 – 2000	**75.5**	**4.674×10^9**	**0**	**NA**	**NA**	**75.5**	**0**
	Pine Creek	TN05130104048 – 3000	**91.4**	**NA***	**NA**	**NA**	**NA**	**91.4**	**0**

Note: NA = Not Applicable.

* Future WWTFs must meet instream water quality standards at the point of discharge as specified in their NPDES permit.

a. *WLAs for WWTFs expressed as E. coli loads (counts/day)*

b. *The objective for leaking collection systems is a waste load allocation of zero. It is recognized, however, that a WLA of 0 counts/day may not be practical. For these sources, the WLA is interpreted to mean a reduction in coliform loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.*

c. *Applies to any MS4 discharge loading in the subwatershed.*

d. *The objective for all "other direct sources" is a load allocation of zero. It is recognized, however, that for leaking septic systems a LA of 0 counts/day may not be practical. For these sources, the LA is interpreted to mean a reduction in coliform loading by the application of best management practices, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.*

PROPOSED PATHOGEN TOTAL MAXIMUM DAILY LOAD (TMDL) PINE CREEK SUBWATERSHED (HUC 05130104)

1.0 INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those waterbodies that are not attaining water quality standards. State water quality standards consist of designated uses for individual waterbodies, appropriate numeric and narrative water quality criteria protective of the designated uses, and an antidegradation statement. The TMDL process establishes the maximum allowable loadings of pollutants for a waterbody that will allow the waterbody to maintain water quality standards. The TMDL may then be used to develop controls for reducing pollution from both point and nonpoint sources in order to restore and maintain the quality of water resources (USEPA, 1991).

2.0 SCOPE OF DOCUMENT

This document presents details of TMDL development for waterbodies in the Pine Creek subwatershed, part of the South Fork Cumberland Watershed, identified on the Final 2004 303(d) list as not supporting designated uses due to E. coli. Portions of the South Fork Cumberland Watershed lie in both Tennessee and Kentucky. This document addresses only impaired waterbodies in Tennessee. TMDL analyses are performed primarily on a 12-digit hydrologic unit area (HUC-12) basis. In some cases, where appropriate, TMDLs are developed for an impaired waterbody drainage area only.

3.0 WATERSHED DESCRIPTION

The South Fork Cumberland Watershed (HUC 05130104) is located in Eastern Tennessee (Figure 1), primarily in Fentress and Scott Counties. The South Fork Cumberland Watershed lies within two Level III ecoregions (Southwestern Appalachians, Central Appalachians) and contains three Level IV ecoregions as shown in Figure 2 (USEPA, 1997). The Pine Creek Subwatershed lies entirely within the Cumberland Plateau (68a) ecoregion:

- **Cumberland Plateau (68a)** tablelands and open low mountains are about 1000 feet higher than the Eastern Highland Rim (71g) to the west, and receive slightly more precipitation with cooler annual temperatures than the surrounding lower-elevation ecoregions. The plateau surface is less dissected with lower relief compared to the Cumberland Mountains (69d) or the Plateau Escarpment (68c). Elevations are generally 1200-2000 feet, with the Crab Orchard Mountains reaching over 3000 feet. Pennsylvanian-age conglomerate, sandstone, siltstone, and shale is covered by well-drained, acid soils of low fertility. Bituminous coal that has been extensively surface and underground mined underlies the region. Acidification of first and second order streams is common. Stream siltation and mine spoil bedload deposits continue as long-term problems in these headwater systems. Pockets of severe acid mine drainage persist.

- **Plateau Escarpment (68c)** is characterized by steep, forested slopes and high velocity, high gradient streams. Local relief is often 1000 feet or more. The geologic strata include Mississippian-age limestone, sandstone, shale, and siltstone, and Pennsylvanian-age shale, siltstone, sandstone, and conglomerate. Streams have cut down into the limestone, but the gorge talus slopes are composed of colluvium with huge angular, slabby blocks of sandstone. Vegetation community types in the ravines and gorges include mixed oak and chestnut oak on the upper slopes, mesic forests on the middle and lower slopes (beech-tulip poplar, sugar maple-basswood-ash-buckeye), with hemlock along rocky streamsides and river birch along floodplain terraces.

- **Cumberland Mountains (69d),** in contrast to the sandstone-dominated Cumberland Plateau (68a) to the west and southwest, are more highly dissected, with narrow-crested steep slopes, and younger Pennsylvanian-age shales, sandstones, siltstones, and coal. Narrow, winding valleys separate the mountain ridges, and relief is often 2000 feet. Cross Mountain, west of Lake City, reaches 3534 feet in elevation. Soils are generally well-drained, loamy, and acidic, with low fertility. The natural vegetation is a mixed mesophytic forest, although composition and abundance vary greatly depending on aspect, slope position, and degree of shading from adjacent landmasses. Large tracts of land are owned by lumber and coal companies, and there are many areas of stripmining. Acid mine drainage is primarily limited to first and second order systems. Siltation as surface run-off remains the primary pollutant from past mining, timber harvest and unpaved roads.

The South Fork Cumberland Watershed, located in Anderson, Campbell, Fentress, Morgan, Pickett, and Scott Counties, Tennessee, has a drainage area of approximately 972 square miles (mi^2) in Tennessee. The entire watershed, including both Tennessee and Kentucky, drains approximately 1,375 square miles. The Pine Creek subwatershed, located entirely in Scott County, has a drainage area of approximately 26.5 square miles (mi^2). Watershed land use distribution is based on the Multi-Resolution Land Characteristic (MRLC) databases derived from Landsat Thematic Mapper digital images from the period 1990-1993. Although changes in the land use of the South Fork Cumberland Watershed have occurred since 1993 as a result of development, this is the most current land use data available. Land use for the Tennessee portion of the South Fork Cumberland Watershed is summarized in Table 1 and shown in Figure 3. Predominant land use in the South Fork Cumberland Watershed is forest (94.0%) followed by pasture (4.1%). Urban areas represent approximately 0.6% of the total drainage area of the watershed. Predominant land use in the Pine Creek subwatershed is forest (81.6%) followed by pasture (9.2%). Urban areas represent approximately 4.6% of the total drainage area of the subwatershed. Details of land use distribution of impaired subwatersheds in the Pine Creek Subwatershed are presented in Appendix A.

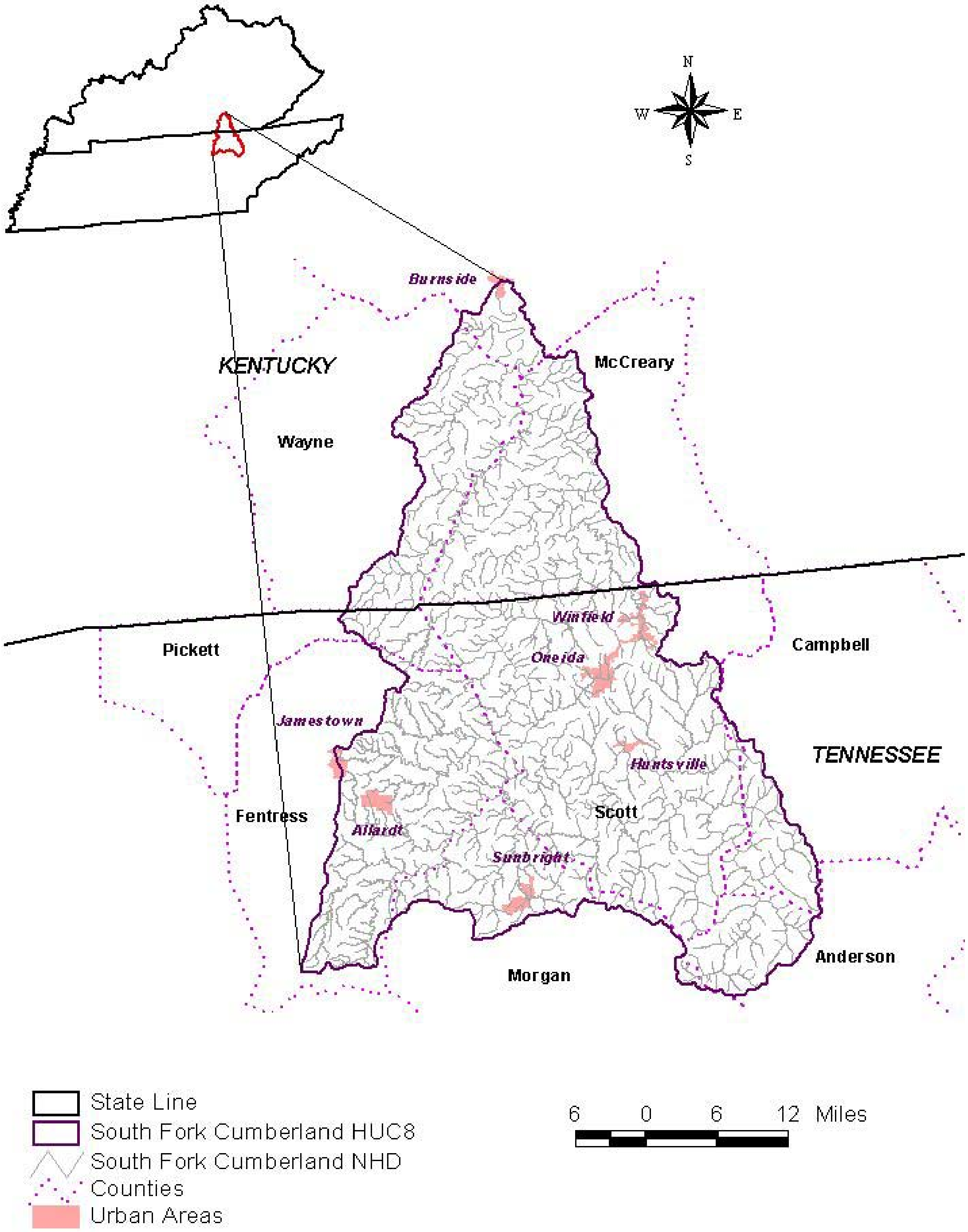

Figure 1. Location of the South Fork Cumberland Watershed.

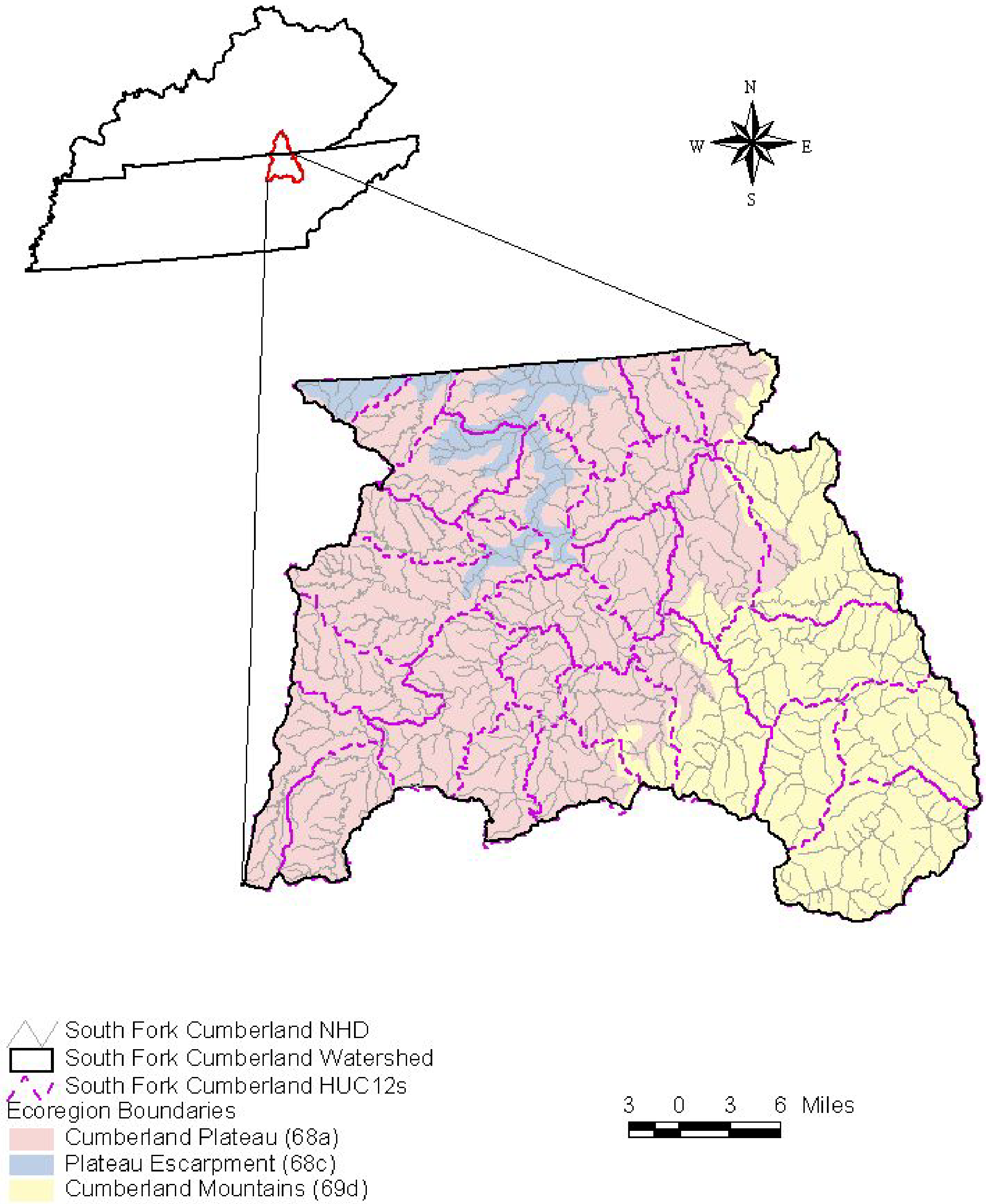

Figure 2. Level IV Ecoregions in the South Fork Cumberland Watershed.

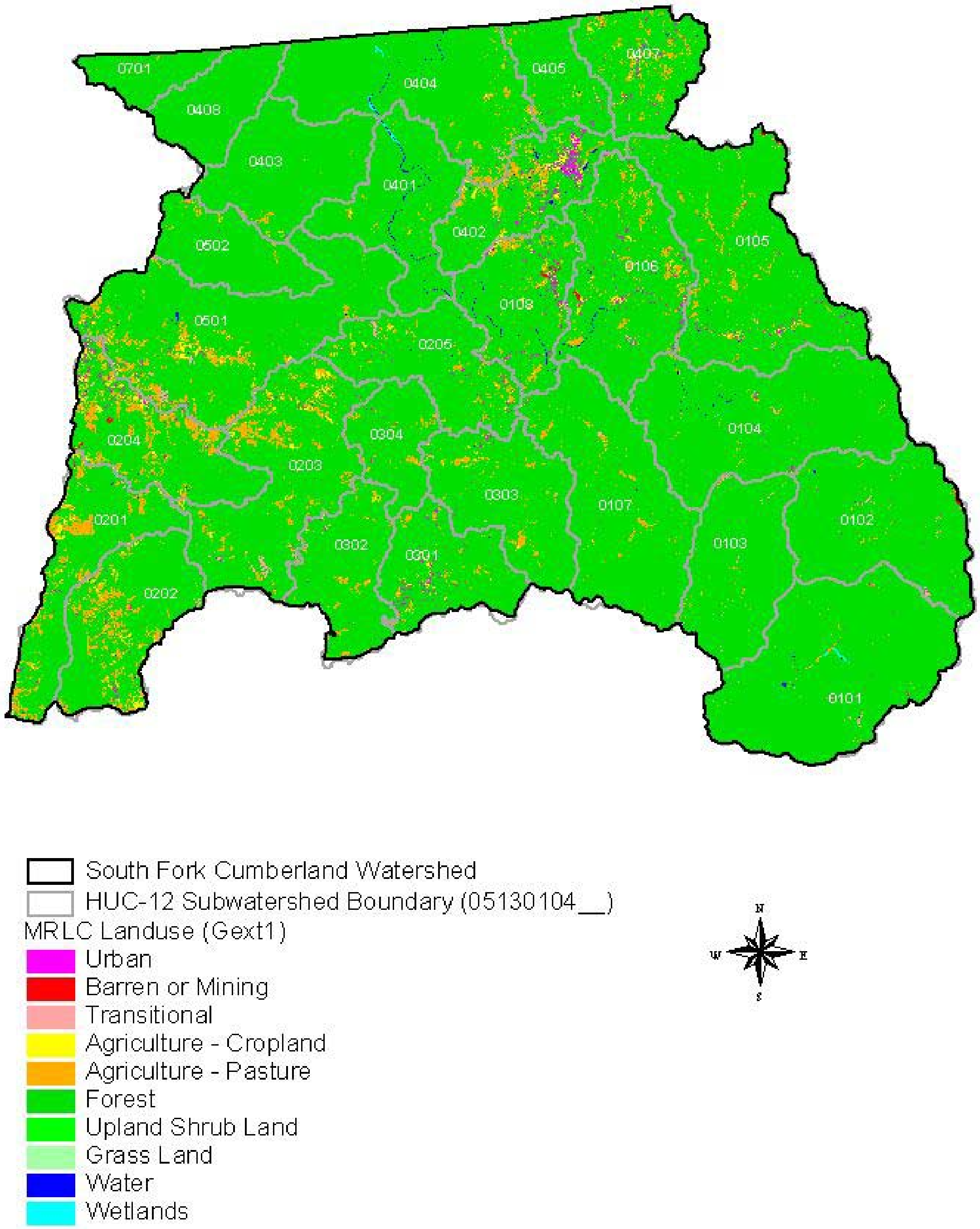

Figure 3. Land Use Characteristics of the South Fork Cumberland Watershed.

Table 1. MRLC Land Use Distribution – South Fork Cumberland Watershed

Land Use	South Fork HUC-8		Pine Creek HUC-12	
	[acres]	[%]	[acres]	[%]
Deciduous Forest	353,921	56.9	6,407.0	37.7
Emergent Herbaceous Wetlands	13	0.0	0	0.0
Evergreen Forest	86,928	14.0	2,440.8	14.4
High Intensity Commercial/Industrial/ Transportation	1,243	0.2	265.5	1.6
High Intensity Residential	116	0.0	59.4	0.4
Low Intensity Residential	2,319	0.4	447.7	2.6
Mixed Forest	143,780	23.1	5,006.1	29.5
Open Water	931	0.1	109.4	0.6
Other Grasses (Urban/recreational)	1,558	0.3	412.5	2.4
Pasture/Hay	25,341	4.1	1,564.1	9.2
Quarries/Strip Mines/ Gravel Pits	282	0.0	0	0.0
Row Crops	3,582	0.6	262.9	1.6
Transitional	1,771	0.3	0	0.0
Woody Wetlands	201	0.0	22.2	0.1
Total	**621,986**	**100.0**	**16,997.6**	**100.0**

4.0 PROBLEM DEFINITION

The State of Tennessee's final 2004 303(d) list (TDEC, 2004a) was approved by the U.S. Environmental Protection Agency (EPA), Region IV in August of 2005. This list identified portions of eight waterbodies in the South Fork Cumberland Watershed as not supporting designated use classifications due, in part, to E. coli (see Table 2). All of these waterbodies are located in the Pine Creek subwatershed (HUC-12 051301040402). The designated use classifications for these waterbodies include fish and aquatic life, irrigation, livestock watering & wildlife, and recreation. Portions of Pine Creek (Mile 10.5 to origin) are also designated for domestic water supply.

When used in the context of waterbody assessments, the term pathogens is defined as disease-causing organisms such as bacteria or viruses that can pose an immediate and serious health threat if ingested or introduced into the body. The primary sources for pathogens are untreated or inadequately treated human or animal fecal matter. The E. coli and fecal coliform groups are indicators of the presence of pathogens in a stream.

The waterbody segments listed in Table 2 were assessed as impaired based on sampling data and/or biological surveys. The results of these assessment surveys are summarized in Table 3 and shown in Figure 4. The assessment information presented is excerpted from the EPA/TDEC Assessment Database (ADB) and is referenced to the waterbody ID in Table 2. ADB information may be accessed at:

http://gwidc.memphis.edu/website/wpc_arcmap

5.0 WATER QUALITY GOAL

As previously stated, the designated use classifications for the South Fork Cumberland waterbodies include fish & aquatic life, recreation, irrigation, and livestock watering & wildlife. Of the use classifications with numeric criteria for pathogens, the recreation use classification is the most stringent and will be used to establish target levels for TMDL development. The coliform water quality criteria, for protection of the recreation use classification, is established by *State of Tennessee Water Quality Standards, Chapter 1200-4-3, General Water Quality Criteria, January 2004* (TDEC, 2004b). Section 1200-4-3-.03 (4) (f) states:

> The concentration of the E. coli group shall not exceed 126 colony forming units per 100 mL, as a geometric mean based on a minimum of 5 samples collected from a given sampling site over a period of not more than 30 consecutive days with individual samples being collected at intervals of not less than 12 hours. For the purposes of determining the geometric mean, individual samples having an E. coli concentration of less than 1 per 100 mL shall be considered as having a concentration of 1 per 100 mL.
>
> Additionally, the concentration of the E. coli group in any individual sample taken from a lake, reservoir, State Scenic River, or Tier II or III stream (1200-4-3-.06) shall not exceed 487 colony forming units per 100 mL. The concentration of the E. coli group in any individual sample taken from any other waterbody shall not exceed 941 colony forming units per 100 mL.

None of the impaired waterbodies in the Pine Creek Subwatershed have been classified as either Tier II or Tier III streams.

Therefore, this TMDL employs the E. coli water quality standard by determining the amount of load reduction required to comply with each of two criteria: 1) the geometric mean standard for E. coli of 126 counts/100mL, and 2) the E. coli sample maximum of 941 counts/100 mL. The most protective (or highest percent of load reduction) of the two criteria will determine the percent reduction(s) required for impaired waterbodies.

Note: In this document, the water quality standards are the instream goals. The term "target concentration" reflects the application of an explicit Margin of Safety (MOS) to the water quality standard. See Section 8.4 for an explanation of MOS.

Table 2. Final 2004 303(d) List for E. coli Impaired Waterbodies – South Fork Cumberland Watershed

Waterbody ID	Impacted Waterbody	Miles/Acres Impaired	Cause (Pollutant)	Pollutant Source
TN05130104048 – 0200	NORTH FORK PINE CREEK	15	Escherichia coli	Septic Tanks
TN05130104048 – 0300	LITTON FORK PINE CREEK	2.5	Escherichia coli	Collection System Failure Septic Tanks
TN05130104048 – 0400	EAST FORK PINE CREEK	2.8	Escherichia coli	Collection System Failure Septic Tanks
TN05130104048 – 0410	UNNAMED TRIB TO PINE CREEK	2.4	Escherichia coli	Collection System Failure Septic Tanks
TN05130104048 – 0500	SOUTH FORK PINE CREEK	1.7	Escherichia coli	Collection System Failure Septic Tanks
TN05130104048 – 1000	PINE CREEK (from mouth to Mill Branch)	3.2	Escherichia coli	Minor Municipal Point Source Collection System Failure
TN05130104048 – 2000	PINE CREEK (from Mill Branch to Laurel Branch)	4.1	Priority organics Nutrients Loss of biological integrity due to siltation Low Dissolved Oxygen Other Habitat Alterations Escherichia coli	Minor Municipal Point Source Collection System Failure Septic Tanks Channelization Contaminated sediments
TN05130104048 – 3000	PINE CREEK (from Laurel Branch to headwaters)	3.0	Creosote Loss of biological integrity due to siltation Nutrients Low Dissolved Oxygen Other Habitat Alterations Escherichia coli	Collection System Failure Septic Tanks Channelization Contaminated sediments

Table 3. Water Quality Assessment of Waterbodies Impaired Due to E. coli – South Fork Cumberland Watershed

Waterbody ID	Segment Name	Comments
TN05130104048 – 0200	NORTH FORK PINE CREEK	Water contact advisory. 2000 TDEC station at mile 0.3 at Hwy 297. E. coli GM=2086.
TN05130104048 – 0300	LITTON FORK PINE CREEK	Water contact advisory. 2000 TDEC station at Hwy 297. E. coli GM=1739.
TN05130104048 – 0400	EAST FORK PINE CREEK	Water contact advisory. 2000 TDEC station at Hwy 297 discharge from reservoir. E. coli GM=39.
TN05130104048 – 0410	UNNAMED TRIB TO PINE CREEK	Water contact advisory. 2000 TDEC station at Jeffers Rd. E. coli GM=2883.
TN05130104048 – 0500	SOUTH FORK PINE CREEK	Water contact advisory. 2000 TDEC station at mile 0.3 (Hartco Rd.) E. coli GM=729.
TN05130104048 – 1000	PINE CREEK	Water contact advisory. 2000 TDEC stations at mile 0.1 (Jeffers Rd) and at mile 3.6 (Toomy). TDEC biological station at Toomy (13 EPT, 41 total genera).
TN05130104048 – 2000	PINE CREEK	Water contact advisory. 2000 TDEC station at mile 6.0 (d/s of Oneida STP)
TN05130104048 – 3000	PINE CREEK	Water contact advisory. 2000 TDEC stations at mile 8.3 (Verdun Rd), mile 10.6 (U.S.Hwy 27), and at mile 11.4 (d/s dame near Hwy 297).

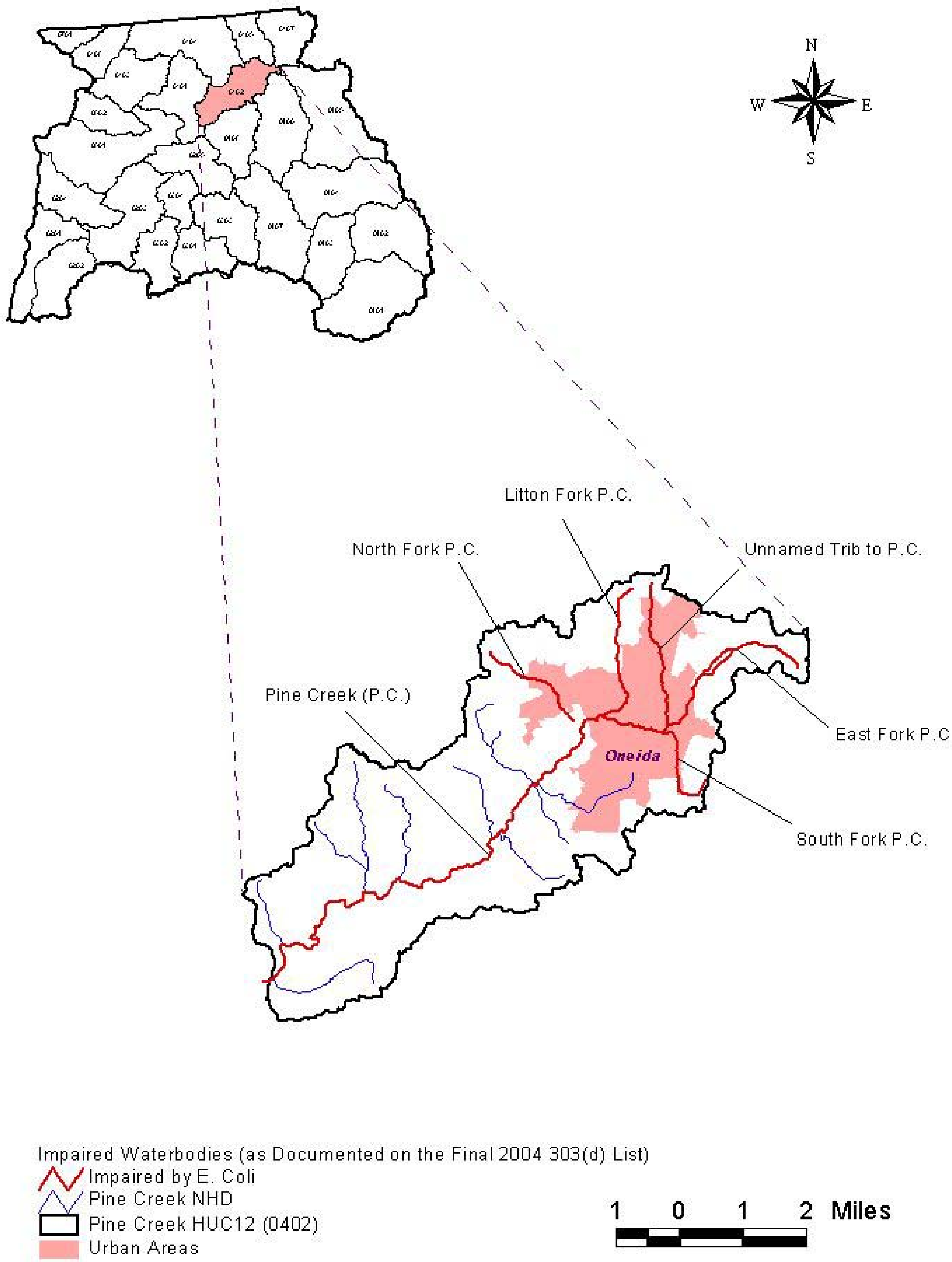

Figure 4. Waterbodies Impaired by E. Coli (as Documented on the Final 2004 303(d) List).

6.0 WATER QUALITY ASSESSMENT AND DEVIATION FROM GOAL

There are several water quality monitoring stations that provide data for waterbodies identified as impaired for E. coli in the South Fork Cumberland Watershed:

- Pine Creek Subwatershed:
  - LITTO000.2SC – Litton Fork Pine Creek, at Hwy 297W
  - NFPIN000.3SC – North Fork Pine Creek, at Hwy 297W
  - SFPIN000.3SC – South Fork Pine Creek, at Hartco Rd.
  - PINE000.1SC – Pine Creek, at Jeffers Rd.
  - PINE003.6SC – Pine Creek, at O&W Rd. and Toomy
  - PINE006.0SC – Pine Creek, at O&W Rd., d/s of Oneida STP
  - PINE008.3SC – Pine Creek, at Verdun Rd. bridge
  - PINE010.6SC – Pine Creek, at Hwy 27
  - PINE011.4SC – Pine Creek, below dam, on Hwy 297

The location of these monitoring stations is shown in Figure 5. Water quality monitoring results for these stations are tabulated in Appendix B. Examination of the data shows violations of the 941 counts/100 mL maximum E. coli standard at many monitoring stations. Water quality monitoring results for those stations with 10% or more of samples in violation of water quality maximum criteria are summarized in Table 4.

There were not enough data to calculate the geometric mean at each monitoring station. Whenever a minimum of 5 samples was collected at a given monitoring station over a period of not more than 30 consecutive days, the geometric mean was calculated.

Note that the three impaired segments of Pine Creek are represented by six water quality monitoring stations. The monitoring station at mile 0.1 is located in segment – 1000 (from the mouth to Mill Branch). The monitoring stations at miles 3.6 and 6.0 are located in segment – 2000 (from Mill Branch to Laurel Branch). The monitoring stations at miles 8.3, 10.6, and 11.4 are located in segment – 3000 (from Laurel Branch to the headwaters).

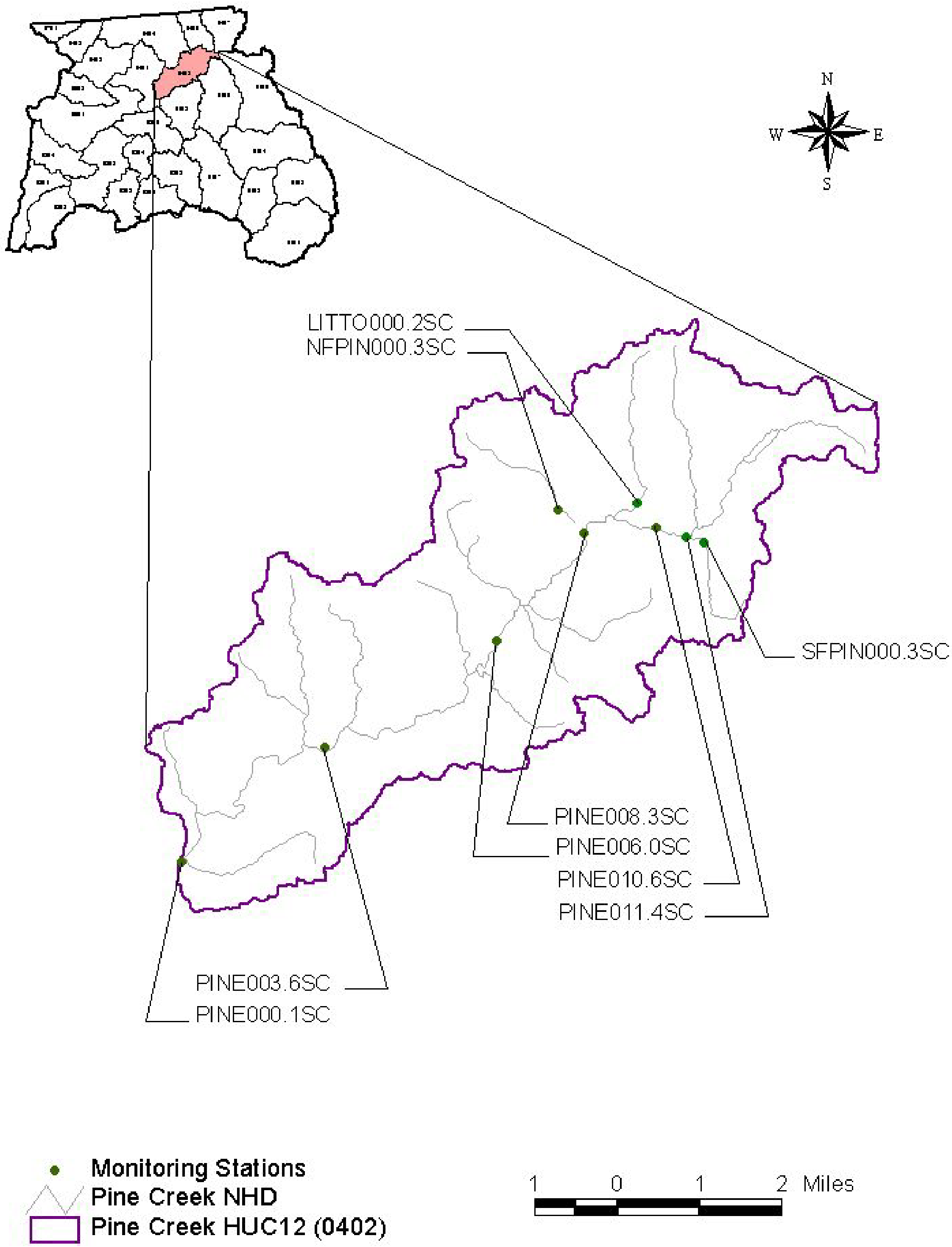

Figure 5. Water Quality Monitoring Stations in the Pine Creek Subwatershed

Table 4. Summary of TDEC Water Quality Monitoring Data

Monitoring Station	Monitoring Dates	E. Coli					
		Data Pts.	[Counts/100 mL]			No. Viol. WQ Crit.	Percent Viol. WQ Crit.
			Min.	Avg.	Max.		
LITTO000.2SC	2000 – 2001	13	15	3,232	24,810	6	46.2%
NFPIN000.3SC	2000 – 2001	13	300	5,918	57,940	7	53.8%
SFPIN000.3SC	2000 – 2001	13	93	1,771	10,810	5	38.5%
PINE000.1SC	2000 – 2001	13	520	8,049	51,720	10	76.9%
PINE003.6SC	2000 – 2004	25	3	473	3,990	4	16.0%
PINE006.0SC	2000 – 2001	13	13	1,371	10,500	4	30.8%
PINE008.3SC	2000 – 2004	25	13	1,086	9,090	5	20.0%
PINE010.6SC	2000 – 2001	13	80	3,339	13,540	6	46.2%

7.0 SOURCE ASSESSMENT

An important part of TMDL analysis is the identification of individual sources, or source categories of pollutants in the watershed that affect pathogen loading and the amount of loading contributed by each of these sources.

Under the Clean Water Act, sources are classified as either point or nonpoint sources. Under 40 CFR §122.2, a point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. The National Pollutant Discharge Elimination System (NPDES) program regulates point source discharges. Point sources can be described by three broad categories: 1) NPDES regulated municipal and industrial wastewater treatment facilities (WWTFs); 2) NPDES regulated industrial and municipal storm water discharges; and 3) NPDES regulated Concentrated Animal Feeding Operations (CAFOs). A TMDL must provide Waste Load Allocations (WLAs) for all NPDES regulated point sources. Nonpoint sources are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. For the purposes of this TMDL, all sources of pollutant loading not regulated by NPDES permits are considered nonpoint sources. The TMDL must provide a Load Allocation (LA) for these sources.

7.1 Point Sources

7.1.1 NPDES Regulated Municipal and Industrial Wastewater Treatment Facilities

Both treated and untreated sanitary wastewater contain coliform bacteria. There are 7 NPDES permitted WWTFs that require monitoring of fecal coliform and/or E. coli within the South Fork Cumberland Watershed. The fecal coliform and E. coli permit limits for discharges from these WWTFs are in accordance with the criteria specified in the 1999 and 2004 State of Tennessee water quality standards (TDEC, 1999 and TDEC, 2004b, respectively) (ref.: Section 5.0).

One of these facilities is located in an impaired subwatershed of the Pine Creek Subwatershed. The Oneida Sewage Treatment Plant (STP) (TN0064424), with a design capacity of 0.98 MGD, discharges to Pine Creek at Mile 7.2.

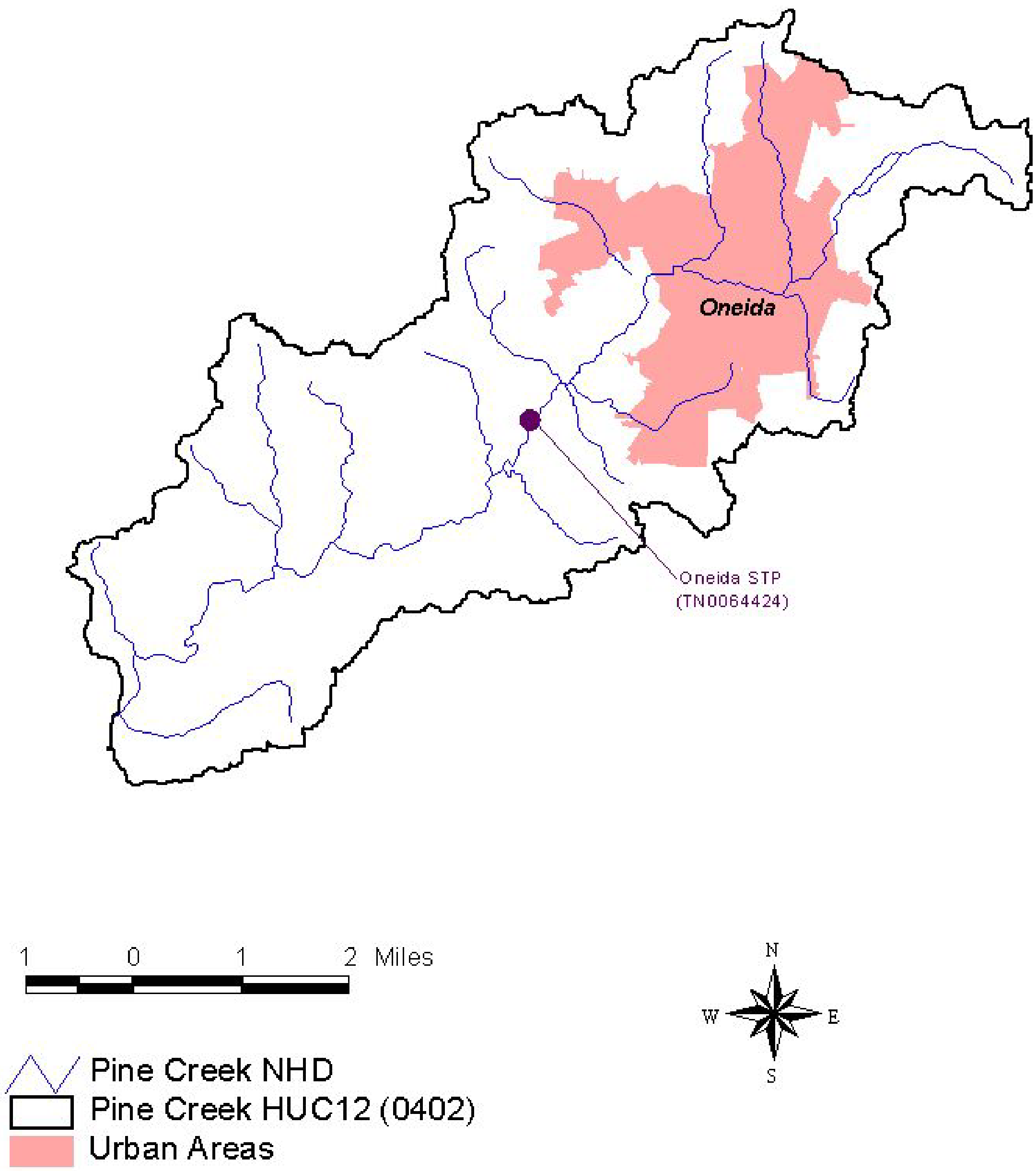

Figure 6. NPDES Regulated Point Sources in the Pine Creek Subwatershed.

7.1.2 NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s)

Municipal Separate Storm Sewer Systems (MS4s) are considered to be point sources of pathogens. Discharges from MS4s occur in response to storm events through road drainage systems, curb and gutter systems, ditches, and storm drains. Large and medium MS4s serving populations greater than 100,000 people are required to obtain NPDES storm water permits. At present, there are no MS4s of this size in the South Fork Cumberland Watershed. As of March 2003, small MS4s serving urbanized areas, or having the potential to exceed instream water quality standards, are required to obtain a permit under the *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2002). An urbanized area is defined as an entity with a residential population of at least 50,000 people and an overall population density of at least 1,000 people per square mile. Under the General Permit, an annual report must be submitted to the Director of TDEC Water Pollution Control Division.

Anderson County is covered under Phase II of the NPDES Storm Water Program (Figure 6). However, there are no South Fork Cumberland watershed E. coli impaired waterbodies in Anderson County. The Tennessee Department of Transportation (TDOT) is also being issued MS4 permits for State roads in urban areas. Information regarding storm water permitting in Tennessee may be obtained from the TDEC website at http://www.state.tn.us/environment/wpc/stormh2o/.

7.1.3 NPDES Concentrated Animal Feeding Operations (CAFOs)

Animal feeding operations (AFOs) are agricultural enterprises where animals are kept and raised in confined situations. AFOs congregate animals, feed, manure and urine, dead animals, and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures, fields, or on rangeland (USEPA, 2002a). Concentrated Animal Feeding Operations (CAFOs) are AFOs that meet certain criteria with respect to animal type, number of animals, and type of manure management system. CAFOs are considered to be potential point sources of pathogen loading and are required to obtain an NPDES permit. Most CAFOs in Tennessee obtain coverage under TNA000000, *Class II Concentrated Animal Feeding Operation General Permit*, while larger, Class I CAFOs are required to obtain an individual NPDES permit.

As of May 11, 2005, there are two Class II CAFOs with coverage under the general NPDES permit and one Class I CAFO with an individual permit located in the South Fork Cumberland Watershed. None of these CAFOs are located in the Pine Creek subwatershed (see Figure 6).

7.2 Nonpoint Sources

Nonpoint sources of coliform bacteria are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not always, involve accumulation of coliform bacteria on land surfaces and wash off as a result of storm events. Nonpoint sources of pathogen loading are primarily associated with agricultural and urban land uses. The majority of waterbodies identified on the Final 2004 303(d) list as impaired due to E. coli are attributed to nonpoint agricultural or urban sources.

7.2.1 Wildlife

Wildlife deposit coliform bacteria, with their feces, onto land surfaces where it can be transported during storm events to nearby streams. The overall deer density for Tennessee was estimated by the Tennessee Wildlife Resources Agency (TWRA) to be 23 animals per square mile. Fecal coliform loads due to deer are estimated by EPA to be 5.0×10^8 counts/animal/day.

7.2.2 Agricultural Animals

Agricultural activities can be a significant source of coliform bacteria loading to surface waters. The activities of greatest concern are typically those associated with livestock operations:

- Agricultural livestock grazing in pastures deposit manure containing coliform bacteria onto land surfaces. This material accumulates during periods of dry weather and is available for washoff and transport to surface waters during storm events. The number of animals in pasture and the time spent grazing are important factors in determining the loading contribution.
- Processed agricultural manure from confined feeding operations is often applied to land surfaces and can provide a significant source of coliform bacteria loading. Guidance for issues relating to manure application is available through the University of Tennessee Agricultural Extension Service and the Natural Resources Conservation Service (NRCS).
- Agricultural livestock and other unconfined animals often have direct access to waterbodies and can provide a concentrated source of coliform bacteria loading directly to a stream.

Potential data sources related to livestock operations include the 2002 Census of Agriculture, which was compiled for the South Fork Cumberland Watershed utilizing the Watershed Characterization System (WCS). WCS is an Arcview geographic information system (GIS) based program developed by USEPA Region IV to facilitate watershed characterization and TMDL development. Livestock information provided in WCS is based on the ratio of watershed pasture area to county pasture area applied to the livestock population within the county. Livestock data for E. coli-impaired watersheds are summarized in Table 5. Populations were rounded to the nearest 25 cows, 50 poultry, and 5 hogs, sheep, and horses.

7.2.3 Failing Septic Systems

Some coliform loading in the Pine Creek Subwatershed can be attributed to failure of septic systems and illicit discharges of raw sewage. Estimates from 1997 county census data of people in the Pine Creek Subwatershed utilizing septic systems were compiled using the WCS and are summarized in Table 6. In middle and eastern Tennessee, it is estimated that there are approximately 2.37 people per household on septic systems, some of which can be reasonably assumed to be failing. As with livestock in streams, discharges of raw sewage provide a concentrated source of coliform bacteria directly to waterbodies.

Table 5. Livestock Distribution in the Pine Creek Subwatershed

Subwatershed	Livestock Population (WCS)					
	Beef Cow	Milk Cow	Poultry	Hogs	Sheep	Horse
Pine Creek (HUC12)	125	0	97,600	0	0	95
Pine Creek (RM3.6)	75	0	74,700	0	0	85
Pine Creek (RM8.3)	50	0	35,800	0	0	30
North Fork Pine Creek	0	0	6,750	0	0	5
Litton Fork Pine Creek	0	0	5,950	0	0	10
South Fork Pine Creek	0	0	4,300	0	0	0

Table 6. Population on Septic Systems in the Pine Creek Subwatershed

Subwatershed	Population on Septic Systems
Pine Creek (HUC12)	718
Pine Creek (RM3.6)	525
Pine Creek (RM8.3)	216
North Fork Pine Creek	45
Litton Fork Pine Creek	41
South Fork Pine Creek	29

7.2.4 Urban Development

Nonpoint source loading of coliform bacteria from urban land use areas is attributable to multiple sources. These include: stormwater runoff, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals. Impervious surfaces in urban areas allow runoff to be conveyed to streams quickly, without interaction with soils and groundwater. All impaired subwatersheds in the Pine Creek Subwatershed have less than 10.0% urban land area. Land use for the Pine Creek impaired drainage areas is summarized in Figures 7 thru 10 and tabulated in Appendix A.

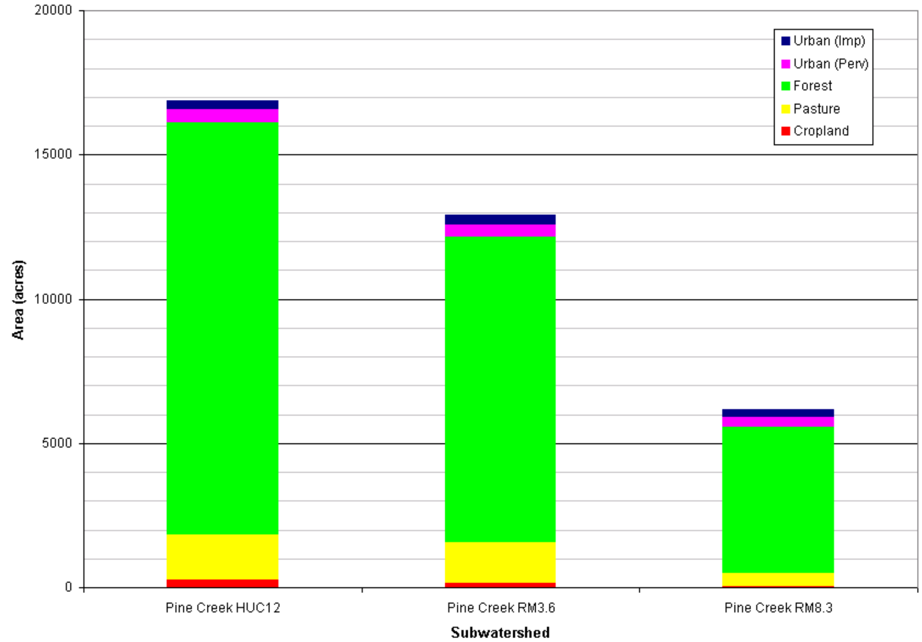

Figure 7. Land Use Area of Pine Creek E.coli-Impaired Subwatersheds – Drainage Areas Greater Than 5,000 Acres.

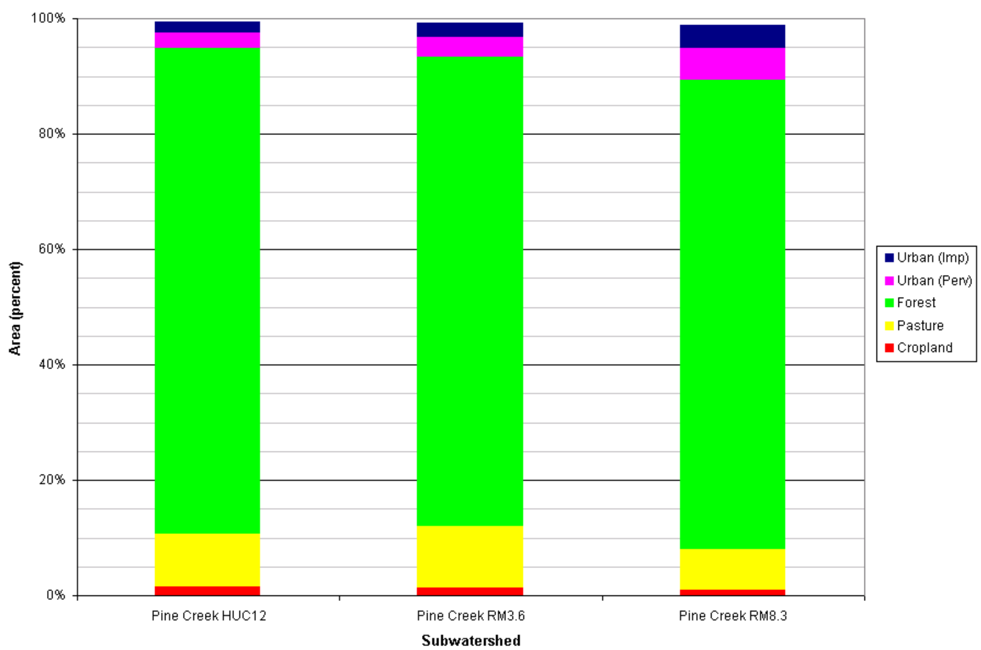

Figure 8. Land Use Percent of the Pine Creek E.coli-Impaired Subwatersheds – Drainage Areas Greater Than 5,000 Acres.

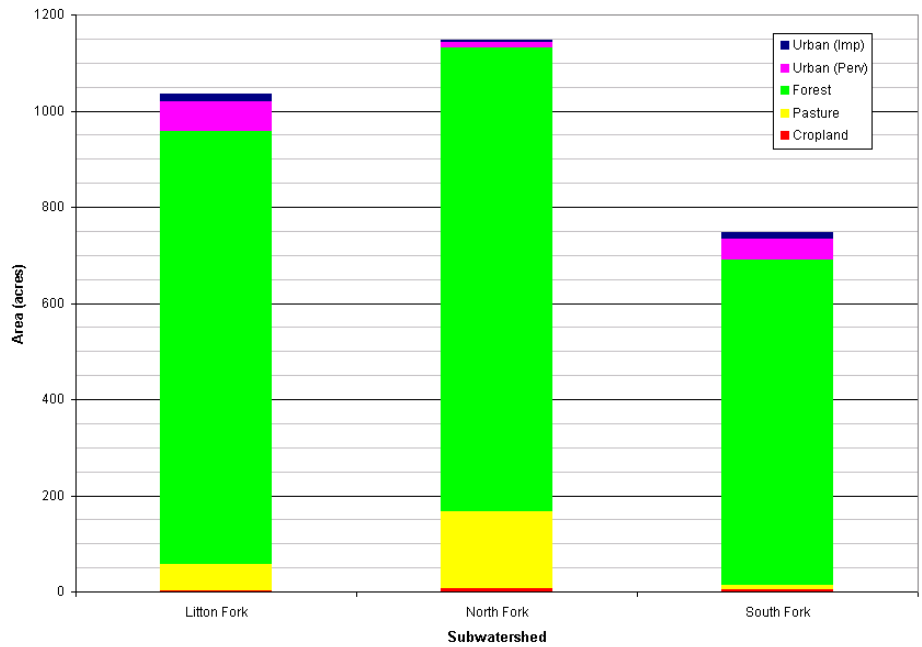

Figure 9. Land Use Area of Pine Creek E.coli-Impaired Subwatersheds – Drainage Areas Less Than 5,000 Acres.

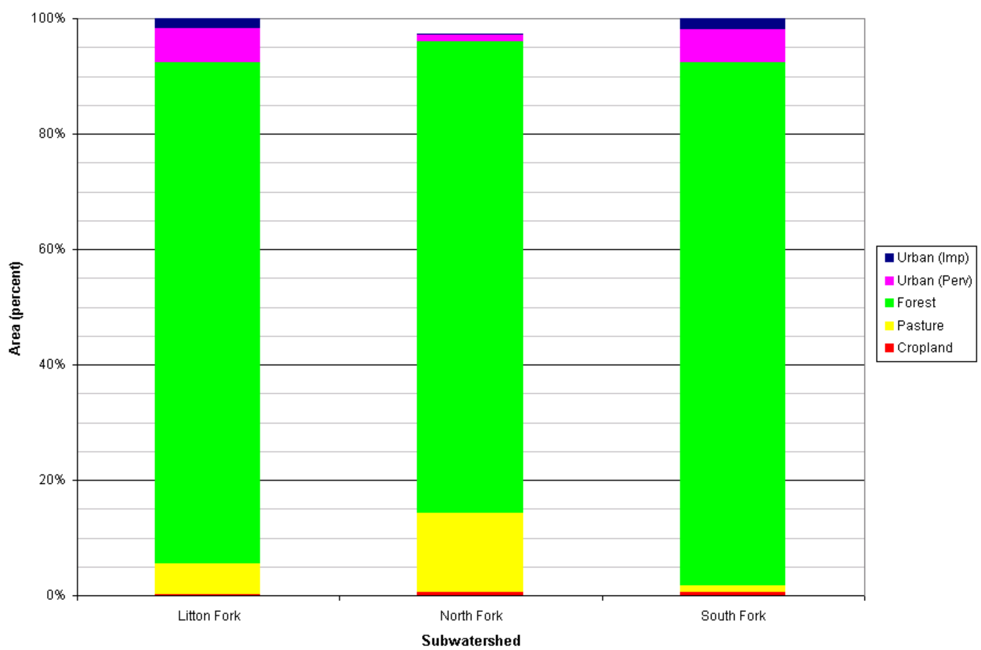

Figure 10. Land Use Percent of the Pine Creek E.coli-Impaired Subwatersheds – Drainage Areas Less Than 5,000 Acres.

8.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOADS

The Total Maximum Daily Load (TMDL) process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load Allocations), and an appropriate margin of safety (MOS) that takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\text{TMDL} = \Sigma\ \text{WLAs} + \Sigma\ \text{LAs} + \text{MOS}$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time, toxicity, or <u>other appropriate measure</u>.

This document describes pathogen TMDL, Waste Load Allocation (WLA), and Load Allocation (LA) development for waterbodies identified as impaired due to E. coli on the Final 2004 303(d) list. TMDL analyses are performed primarily on a 12-digit hydrologic unit area (HUC-12) basis for subwatersheds containing waterbodies identified as impaired due to E. coli on the Final 2004 303(d) list.

8.1 Expression of TMDLs, WLAs, & LAs

In this document, the pathogen TMDL is expressed as the percent reduction in instream loading required to decrease existing E. coli concentrations to desired target levels. Target concentrations are equal to the desired water quality goals (see Section 5.0) minus the appropriate MOS. WLAs & LAs for precipitation-induced loading sources are also expressed as required percent reductions in pathogen loading. Allocations for loading that is independent of precipitation (WLAs for WWTFs and LAs for “other direct sources”) are expressed as counts/day.

8.2 TMDL Analysis Methodology

Establishing the relationship between in-stream water quality and source loading is an important component of TMDL development. It allows the determination of the relative contribution of sources to total pollutant loading and the evaluation of potential changes to water quality resulting from implementation of various management options. This relationship can be developed using a variety of techniques ranging from qualitative assumptions based on scientific principles to numerical computer modeling.

TMDLs for the Pine Creek Subwatershed were developed using load duration curves for analysis of impaired waterbodies. A load duration curve (LDC) is a cumulative frequency graph that illustrates existing water quality conditions (as represented by loads calculated from monitoring data), how these conditions compare to desired targets, and the portion of the waterbody flow regime represented by these existing loads. Load duration curves were considered to be well suited for analysis of periodic monitoring data collected by grab sample. LDCs were developed at monitoring site locations in impaired waterbodies and an overall load reduction calculated to meet E. coli targets according to the methods described in Appendix C.

8.3 Critical Conditions and Seasonal Variation

The critical condition for non-point source coliform loading is an extended dry period followed by a rainfall runoff event. During the dry weather period, E. coli bacteria builds up on the land surface, and is washed off by rainfall. The critical condition for point source loading occurs during periods of low streamflow when dilution is minimized. Both conditions are represented in the TMDL analysis.

The ten-year period from October 1, 1994 to September 30, 2004 was used to simulate flow. This 10-year period contained a range of hydrologic conditions that included both low and high streamflows. Critical conditions are accounted for in the load duration curve analysis by using the entire period of flow and water quality data available for the impaired waterbodies. In all subwatersheds, water quality data have been collected during most flow ranges. Based on the location of the water quality exceedances on the load duration curves, no one delivery mode for pathogens appears to be dominant (see Section 9.3 and Table 10).

Seasonal variation was incorporated in the load duration curves by using the entire simulation period and all water quality data collected at the monitoring stations. The water quality data were not collected during all seasons.

8.4 Margin of Safety

There are two methods for incorporating an MOS in the analysis: a) implicitly incorporate the MOS using conservative model assumptions; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations.

An explicit MOS, equal to 10% of the E. coli water quality goals (ref.: Section 5.0), was utilized for TMDL analysis. Explicit MOS and the resulting target concentrations are shown in Table 7.

Table 7. Explicit MOS and Target Concentrations

Pollutant	WQ Goal Type	WQ Goal [cts./100mL]	Explicit MOS [cts./100mL]	Target [cts./100mL]
E. coli	Maximum	941	94	847
	30-Day Geometric Mean	126	13	113

8.5 Determination of TMDLs

E. coli load reductions were calculated for impaired segments in the Pine Creek Subwatershed using Load Duration Curves to evaluate compliance with the maximum target concentrations (Appendix C). When sufficient data were available, load reductions were also developed to achieve compliance with the 30-day geometric mean target concentrations (Appendix C). All of the instream load reductions for a particular waterbody were compared and the largest required load reduction was selected as the TMDL. These TMDL load reductions for the impaired segments are shown in Table 8. A site-specific TMDL could not be developed for East Fork Pine Creek or Unnamed Trib to Pine Creek due to lack of site-specific monitoring data. However, due to their proximity to South Fork Pine Creek, the load reduction for South Fork Pine Creek was applied to East Fork Pine Creek and Unnamed Trib to Pine Creek. In cases where the geometric mean could not be developed, it is assumed that achieving the load reduction based on the maximum target concentrations should result in attainment of the geometric mean criteria.

8.6 Determination of WLAs & LAs

WLAs & LAs are developed in Appendix F for point sources and nonpoint sources respectively. TMDLs, WLAs, & LAs for Pine Creek Subwatershed impaired waterbodies are summarized in Table 9.

Table 8. Determination of TMDLs for Impaired Waterbodies, Pine Creek Subwatershed

HUC-12 Subwatershed (05130104__) or Drainage Area	Impaired Waterbody Name	Impaired Waterbody ID	Required Load Reduction [%]		
			Based on Target Maximum Concentration	Based on 30-day Geometric Mean Concentration	TMDL
0402	North Fork Pine Creek	TN05130104048 – 0200	**>78.1**	**93.7**	**93.7**
	Litton Fork Pine Creek	TN05130104048 – 0300	**>88.2**	**80.5**	**>88.2**
	East Fork Pine Creek[a]	TN05130104048 – 0400			**>80.0**
	Unnamed Trib to Pine Creek[a]	TN05130104048 – 0410			
	South Fork Pine Creek	TN05130104048 – 0500	**>80.0**	**79.9**	
	Pine Creek	TN05130104048 – 1000	**>96.3**	**96.4**	**96.4**
	Pine Creek	TN05130104048 – 2000	**68.7**	**66.9**	**68.7**
	Pine Creek	TN05130104048 – 3000	**>91.0**	**91.0**	**>91.0**

[a] A site-specific TMDL could not be developed for these waterbodies due to lack of monitoring data.

Table 9. WLAs & LAs for Pine Creek Subwatershed, Tennessee

HUC-12 Subwatershed (05130104__) or Drainage Area	Impaired Waterbody Name	Impaired Waterbody ID	WLAs				LAs	
			WWTFs[a] (Monthly Avg.) E. Coli	Leaking Collection Systems[b]	CAFOs	MS4s[c]	Precipitation Induced Nonpoint Sources	Other Direct Sources[d]
			[cts./day]	[cts./day]	[cts./day]	[% Red.]	[% Red.]	[cts./day]
0402	North Fork Pine Creek	TN05130104048 – 0200	**NA***	**NA**	**NA**	**NA**	**93.7**	**0**
	Litton Fork Pine Creek	TN05130104048 – 0300	**NA***	**NA**	**NA**	**NA**	**>88.2**	**0**
	East Fork Pine Creek	TN05130104048 – 0400	**NA***	**NA**	**NA**	**NA**	**>80.0**	**0**
	Unnamed Trib to Pine Creek	TN05130104048 – 0410						
	South Fork Pine Creek	TN05130104048 – 0500						
	Pine Creek	TN05130104048 – 1000	**4.674×10^9**	**0**	**NA**	**NA**	**96.4**	**0**
	Pine Creek	TN05130104048 – 2000	**4.674×10^9**	**0**	**NA**	**NA**	**68.7**	**0**
	Pine Creek	TN05130104048 – 3000	**NA***	**NA**	**NA**	**NA**	**>91.0**	**0**

Note: NA = Not Applicable.

* Future WWTFs must meet instream water quality standards at the point of discharge as specified in their NPDES permit.

a. WLAs for WWTFs expressed as E. coli loads (counts/day)

b. The objective for leaking collection systems is a waste load allocation of zero. It is recognized, however, that a WLA of 0 counts/day may not be practical. For these sources, the WLA is interpreted to mean a reduction in coliform loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.

c. Applies to any MS4 discharge loading in the subwatershed.

d. The objective for all "other direct sources" is a load allocation of zero. It is recognized, however, that for leaking septic systems a LA of 0 counts/day may not be practical. For these sources, the LA is interpreted to mean a reduction in coliform loading by the application of best management practices, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.

9.0 IMPLEMENTATION PLAN

The TMDLs, WLAs, and LAs developed in Section 8 are intended to be the first phase of a long-term effort to restore the water quality of impaired waterbodies in the Pine Creek Subwatershed through reduction of excessive pathogen loading. Adaptive management methods, within the context of the State's rotating watershed management approach, will be used to modify TMDLs, WLAs, and LAs as required to meet water quality goals.

9.1 Point Sources

9.1.1 NPDES Regulated Municipal and Industrial Wastewater Treatment Facilities

All present and future discharges from industrial and municipal wastewater treatment facilities are required to be in compliance with the conditions of their NPDES permits at all times. In Tennessee, permit limits for treated sanitary wastewater require compliance with coliform water quality standards (ref: Section 5.0) prior to discharge. No additional reduction is required. WLAs for WWTFs are expressed as average loads in counts per day. WLAs are derived from facility design flows and permitted E. coli limits.

In order to meet water quality criteria for the Pine Creek Subwatershed, all STPs must meet the provisions of their NPDES permits, including elimination of bypasses and overflows.

9.1.2 NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s)

For regulated discharges from municipal separate storm sewer systems, WLAs will be implemented through Phase I & II MS4 permits. These permits will require the development and implementation of a Storm Water Management Program (SWMP) that will reduce the discharge of pollutants to the "maximum extent practicable" and not cause or contribute to violations of State water quality standards. The *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2002) was issued on February 27, 2003 and requires SWMPs to include six minimum control measures:

- Public education and outreach on storm water impacts
- Public involvement/participation
- Illicit discharge detection and elimination
- Construction site storm water runoff control
- Post-construction storm water management in new development and re-development
- Pollution prevention/good housekeeping for municipal operations

For discharges into impaired waters, the proposed Small MS4 General Permit (ref: http://www.state.tn.us/environment/wpc/stormh2o/MS4II.php) requires that SWMPs include a section describing how discharges of pollutants of concern will be controlled to ensure that they do not cause or contribute to instream exceedances of water quality standards. Specific measures and

BMPs to control pollutants of concern must also be identified. In addition, MS4s must implement the WLA provisions of an applicable TMDL and describe methods to evaluate whether storm water controls are adequate to meet the WLA.

Implementation of the coliform WLAs for MS4s in this TMDL document will require effluent or instream monitoring to evaluate SWMP effectiveness with respect to reduction of pathogen loading.

9.1.3 NPDES Regulated Concentrated Animal Feeding Operations (CAFOs)

WLAs provided to CAFOs will be implemented through NPDES Permit No. TNA000000, General NPDES Permit for *Class II Concentrated Animal Feeding Operation* or the facility's individual permit. Among the provisions of the general permit are:

- Development and implementation of a site-specific Nutrient Management Plan (NMP) that:
  - Includes best management practices (BMPs) and procedures necessary to implement applicable limitations and standards;
  - Ensures adequate storage of manure, litter, and process wastewater including provisions to ensure proper operation and maintenance of the storage facilities.
  - Ensures proper management of mortalities (dead animals);
  - Ensures diversion of clean water, where appropriate, from production areas;
  - Identifies protocols for manure, litter, wastewater and soil testing;
  - Establishes protocols for land application of manure, litter, and wastewater;
  - Identifies required records and record maintenance procedures.

  The NMP must submitted to the State for approval and a copy kept on-site.

- Requirements regarding manure, litter, and wastewater land application BMPs.

- Requirements for the design, construction, operation, and maintenance of CAFO liquid waste management systems that are constructed, modified, repaired, or placed into operation after April 13, 2006. The final design plans and specifications for these systems must meet or exceed standards in the NRCS Field Office Technical Guide and other guidelines as accepted by the Departments of Environment and Conservation, or Agriculture.

Provisions of individual CAFO permits are similar. NPDES Permit No. TNA000000, *Class II Concentrated Animal Feeding Operation General Permit* is available on the TDEC website at http://www.state.tn.us/environment/wpc/programs/cafo/ .

9.2 Nonpoint Sources

The Tennessee Department of Environment & Conservation (TDEC) has no direct regulatory authority over most nonpoint source discharges. Reductions of pathogen loading from nonpoint sources (NPS) will be achieved using a phased approach. Voluntary, incentive-based mechanisms will be used to implement NPS management measures in order to assure that measurable reductions in pollutant loadings can be achieved for the targeted impaired waters. Cooperation and active participation by the general public and various industry, business, and environmental groups is critical to successful implementation of TMDLs. Local citizen-led and implemented management measures offer the most efficient and comprehensive avenue for reduction of loading rates from nonpoint sources. There are links to a number of publications and information resources on EPA's Nonpoint Source Pollution web page (http://www.epa.gov/owow/nps/pubs.html) relating to the implementation and evaluation of nonpoint source pollution control measures.

TMDL implementation activities will be accomplished within the framework of Tennessee's Watershed Approach (ref: http://www.state.tn.us/environment/wpc/watershed/). The Watershed Approach is based on a five-year cycle and encompasses planning, monitoring, assessment, TMDLs, WLAs/LAs, and permit issuance. It relies on participation at the federal, state, local and nongovernmental levels to be successful.

BMPs have been utilized in the South Fork Cumberland Watershed to reduce the amount of coliform bacteria transported to surface waters from agricultural sources. These BMPs (e.g., animal waste management systems, waste utilization, stream stabilization, fencing, heavy use area treatment, livestock exclusion, etc.) may have contributed to reductions in in-stream concentrations of coliform bacteria in the Pine Creek Subwatershed during the TMDL evaluation period. The TDA keeps a database of BMPs implemented in Tennessee. Those listed in the Pine Creek Subwatershed are shown in Figure 11. It is recommended that additional information (e.g., livestock access to streams, manure application practices, etc.) be provided and evaluated to better identify and quantify agricultural sources of coliform bacteria loading in order to minimize uncertainty in future modeling efforts.

It is further recommended that BMPs be utilized to reduce the amount of coliform bacteria transported to surface waters from agricultural sources. Demonstration sites for various types of BMPs should be established, maintained, and evaluated (performance in source reduction) over a period of at least two years prior to recommendations for utilization for subsequent implementation. E. coli sampling and monitoring are recommended during low-flow (baseflow) and storm periods at sites with and without BMPs and/or before and after implementation of BMPs.

An excellent example of stakeholder involvement and action for the implementation of the nonpoint source load allocations (LAs) specified in an approved TMDL is described in *Guidance for Development of a Total Maximum Daily Load Implementation Plan for Fecal Coliform Reduction* (SCWA, 2004), prepared by the Sinking Creek Watershed Alliance. This document details the cooperative effort of a number of stakeholders and governmental entities to develop an implementation plan for the restoration of water quality in Sinking Creek, near Johnson City, Tennessee. Plan development was funded, in part, through a TDEC 604(b) grant and a Tennessee Department of Agriculture (TDA) Nonpoint source Program 319 grant. The plan is based on land use and pollutant source identification surveys and considers public education & participation, funding resources, in-stream monitoring, best management practices (BMPs), and stakeholder responsibilities. Recommendations for future activities include verification of chemical/biological findings through Bacteria Source Tracking (BST) research, implementation of appropriate BMPs, post implementation monitoring to verify reduction of pollutant loading.

The Town of Oneida is currently in the process of connecting every residence to the public wastewater system for a total project cost of about $5.5 million. Construction is being funded, in part, through a United States Department of Agriculture (USDA) Rural Development grant. Elimination of leaking septic tanks is expected to reduce ground and surface water contamination in the Pine Creek subwatershed.

9.3 Application of Load Duration Curves for Implementation Planning

The Load Duration Curve methodology (Appendix C) is a form of water quality analysis and presentation of data that aids in guiding implementation by targeting strategies to appropriate flow conditions. One of the strengths of this method is that it can be used to interpret possible delivery mechanisms of pathogens by differentiating between point and non-point problems. The E. coli load duration analysis was utilized for implementation planning. The E. coli load duration curve for each E. coli-impaired subwatershed (e.g. Figure 12) can be analyzed to determine the frequency with which water quality monitoring data exceed the E. coli target maximum concentration of 847 counts/100 mL (standard – MOS) under five flow conditions (low, dry, mid- range, moist, and high).

Table 10 presents targeted implementation strategies for each source category covering the entire range of flow (Stiles, 2003). Each implementation strategy addresses a range of flow conditions and targets point sources, non-point sources, or a combination of each. Results indicate the implementation strategy for all subwatersheds will require BMPs targeting a variety of sources. The implementation strategies listed in Table 10 are a subset of the categories of BMPs and implementation strategies available for application to the E. coli-impaired South Fork Cumberland Watersheds for reduction of pathogen loading and mitigation of water quality impairment.

See Appendix C for a detailed discussion of the Load Duration Curve Methodology applied to the Pine Creek Subwatershed.

9.4 Additional Monitoring

Documenting progress in reducing the quantity of pathogens entering the South Fork Cumberland Watershed is an essential element of the TMDL Implementation Plan. Additional monitoring and assessment activities are recommended to determine whether implementation of TMDLs, WLAs, & LAs in tributaries and upstream reaches will result in achievement of instream water quality targets for E. coli. Future monitoring activities should be representative of all seasons and a full range of flow and meteorological conditions. Monitoring activities should also be adequate to assess water quality using the 30-day geometric mean standard.

Tennessee's watershed management approach specifies a five-year cycle for planning and assessment. Each watershed will be examined (or re-examined) on a rotating basis. Generally, in years two and three of the five-year cycle, water quality data are collected in support of water quality assessment (including TMDL development) and planning activities. Therefore, a watershed TMDL is developed one to two years prior to commencement of the next cycle's monitoring period.

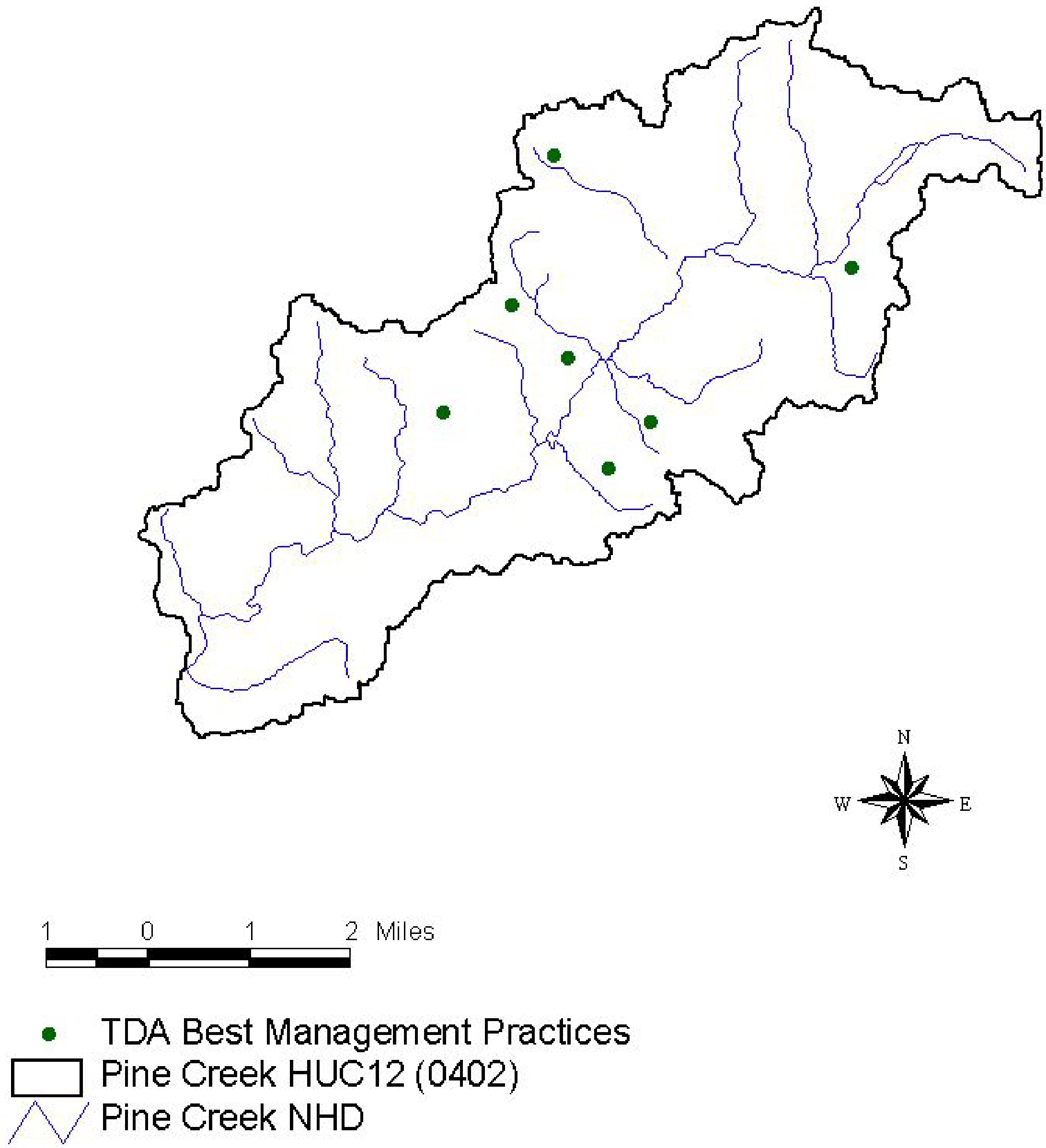

Figure 11. Tennessee Department of Agriculture Best Management Practices located in the Pine Creek Subwatershed.

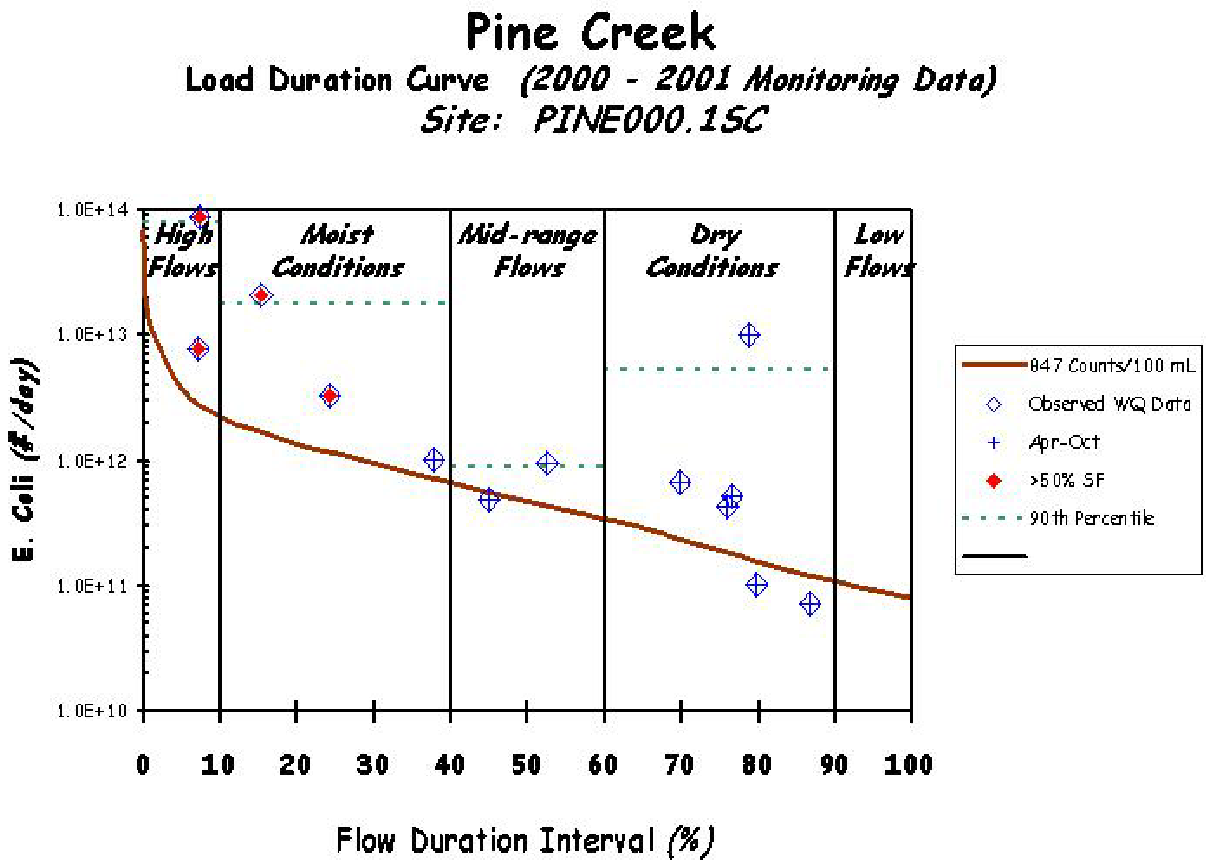

Figure 12. Load Duration Curve for Pine Creek at RM0.1

Additional monitoring and assessment activities are recommended for all impaired waterbodies in the Pine Creek Subwatershed. While historical sampling (e.g. 10 samples in 60 days) allowed for the 30-day geometric mean to be calculated, few other sampling events have occurred in the past five years and this sampling was not representative of all seasons and flow conditions. Once additional monitoring representing all seasons and a full range of flow and meteorological conditions has been obtained, the required load reductions may be revised.

Sufficient monitoring data was available for two impaired waterbodies (Pine Creek at RM3.6 and RM8.3) to allow comparison of two different time periods (see Appendix E). Analysis of the monitoring data suggests that improvement may have occurred at RM8.3. However, additional monitoring will be required until water quality standards have been achieved.

9.5 Source Identification

An important aspect of pathogen load reduction activities is the accurate identification of the actual sources of pollution. In cases where the sources of pathogen impairment are not readily apparent, Microbial Source Tracking (MST) is one approach to determining the sources of fecal pollution and pathogens affecting a waterbody. Those methods that use bacteria as target organisms are also known as Bacterial Source Tracking (BST) methods. This technology is recommended for source identification in E. coli impaired waterbodies.

Bacterial Source Tracking is a collective term used for various emerging biochemical, chemical, and molecular methods that have been developed to distinguish sources of human and non-human fecal pollution in environmental samples (Shah, 2004). In general, these methods rely on genotypic (also known as “genetic fingerprinting”), or phenotypic (relating to the physical characteristics of an organism) distinctions between the bacteria of different sources. Three primary genotypic techniques are available for BST: ribotyping, pulsed field gel electrophoresis (PFGE), and polymerase chain reaction (PCR). Phenotypic techniques generally involve an antibiotic resistance analysis (Hyer, 2004).

The USEPA has published a fact sheet that discusses BST methods and presents examples of BST application to TMDL development and implementation (USEPA, 2002b). Various BST projects and descriptions of the application of BST techniques used to guide implementation of effective BMPs to remove or reduce fecal contamination are presented. The fact sheet can be found on the following EPA website: http://www.epa.gov/owm/mtb/bacsortk.pdf.

A multi-disciplinary group of researchers is developing and testing a series of different microbial assay methods based on real-time PCR to detect fecal bacterial concentrations and host sources in water samples (McKay, 2005). The assays have been used in a study of fecal contamination and have proven useful in identification of areas where cattle represent a significant fecal input and in development of BMPs. It is expected that these types of assays could have broad applications in monitoring fecal impacts from Animal Feeding Operations, as well as from wildlife and human sources. Other BST projects have been conducted or are currently in progress throughout the state of Tennessee, as presented in sessions of the Thirteenth Tennessee Water Resources Symposium (Lawrence, 2003) and the Fifteenth Tennessee Water Resources Symposium (Bailey, 2005; Baldwin, 2005; Farmer, 2005).

9.6 Evaluation of TMDL Implementation Effectiveness

The effectiveness of the TMDL will be assessed within the context of the State's rotating watershed management approach. Watershed monitoring and assessment activities will provide information by which the effectiveness of pathogen loading reduction measures can be evaluated. Additional monitoring data, ground-truthing activities, and bacterial source identification actions are recommended to enable implementation of particular types of BMPs to be directed to specific areas in impaired subwatersheds. This will optimize utilization of resources to achieve maximum reductions in pathogen loading. These TMDLs will be re-evaluated during subsequent watershed cycles and revised as required to assure attainment of applicable water quality standards.

Table 10. Example Implementation Strategies

Flow Condition	High	Moist	Mid-range	Dry	Low
% Time Flow Exceeded	0-10	10-40	40-60	60-90	90-100
Municipal NPDES		L	M	H	H
Stormwater Management		H	H	H	
SSO Mitigation	H	H	M	L	
Collection System Repair		L	M	H	H
Septic System Repair		L	M	H	M
Livestock Exclusion[1]			M	H	H
Pasture Management/Land Application of Manure[1]	H	H	M	L	
Riparian Buffers[1]		H	H	H	
Potential for source area contribution under given hydrologic condition (H: High; M: Medium; L: Low)					

[1] Example Best Management Practices (BMPs) for Agricultural Source reduction. Actual BMPs applied may vary.

10.0 PUBLIC PARTICIPATION

In accordance with 40 CFR §130.7, the proposed pathogen TMDLs for the Pine Creek Subwatershed was placed on Public Notice for a 35-day period and comments solicited. Steps that were taken in this regard include:

1) Notice of the proposed TMDLs were posted on the Tennessee Department of Environment and Conservation website. The announcement invited public and stakeholder comment and provided a link to a downloadable version of the TMDL document.

2) Notice of the availability of the proposed TMDLs (similar to the website announcement) was included in one of the NPDES permit Public Notice mailings which is sent to approximately 90 interested persons or groups who have requested this information.

3) Letters were sent to WWTFs located in or near E. coli-impaired subwatersheds in the Pine Creek Subwatershed, permitted to discharge treated effluent containing E. coli, advising them of the proposed TMDLs and their availability on the TDEC website. The letters also stated that a copy of the draft TMDL document would be provided on request. A letter was sent to the following facilities:

   Oneida STP (TN0064424)

4) A draft copy of the proposed TMDL was sent to those MS4s that are wholly or partially located in E. coli-impaired subwatersheds. A draft copy was sent to the following entities:

   Tennessee Dept. of Transportation (TNS077585)

5) A letter was sent to water quality partners in the South Fork Cumberland Watershed advising them of the proposed pathogen TMDLs and their availability on the TDEC website. The letter also stated that a written copy of the draft TMDL document would be provided upon request. A letter was sent to the following partners:

   Natural Resources Conservation Service
   Tennessee Valley Authority
   United States Forest Service
   Tennessee Department of Agriculture
   Tennessee Wildlife Resources Agency
   Upper Cumberland Water Watch (Kentucky)
   Cumberland River Compact
   The Nature Conservancy

11.0 FURTHER INFORMATION

Further information concerning Tennessee's TMDL program can be found on the Internet at the Tennessee Department of Environment and Conservation website:

http://www.state.tn.us/environment/wpc/tmdl/

Technical questions regarding this TMDL should be directed to the following members of the Division of Water Pollution Control staff:

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APPENDIX A

Land Use Distribution in the Pine Creek Subwatershed

Table A-1. MRLC Land Use Distribution of Pine Creek Subwatersheds

Land Use	Pine Creek Subwatersheds					
	Pine Creek HUC12		Pine Creek RM3.6		Pine Creek RM8.3	
	[acres]	[%]	[acres]	[%]	[acres]	[%]
Deciduous Forest	6,407.0	37.7	4,838.6	37.2	2,420.8	38.8
Evergreen Forest	2,440.8	14.4	1,637.7	12.6	636.7	10.2
High Intensity Commercial/Industrial/Transp.	265.5	1.6	257.3	2.0	195.0	3.1
High Intensity Residential	59.4	0.4	59.4	0.5	55.6	0.9
Low Intensity Residential	447.7	2.6	446.8	3.4	334.5	5.4
Mixed Forest	5,006.1	29.5	3,662.4	28.2	1,680.0	27.0
Open Water	109.4	0.6	105.9	0.8	76.1	1.2
Other Grasses (Urban/recreation; e.g. parks)	412.5	2.4	411.2	3.2	313.6	5.0
Pasture/Hay	1,564.1	9.2	1,396.0	10.7	443.7	7.1
Row Crops	262.9	1.6	169.2	1.3	56.3	0.9
Transitional	22.2	0.1	22.2	0.2	22.0	0.4
Total	16,997.6	100.0	13,006.8	100.0	6,234.2	100.0

Table A-1 (Cont.). MRLC Land Use Distribution of Pine Creek Subwatersheds

Land Use	Pine Creek Subwatersheds					
	Litton Fork Pine Creek		North Fork Pine Creek		South Fork Pine Creek	
	[acres]	[%]	[acres]	[%]	[acres]	[%]
Deciduous Forest	357.4	34.5	497.1	42.2	358.9	48.0
Evergreen Forest	116.5	11.3	128.5	10.9	94.3	12.6
High Intensity Commercial/Industrial/Transp.	3.1	0.3	1.6	0.1	8.2	1.1
High Intensity Residential	10.5	1.0	0.9	0.1	2.0	0.3
Low Intensity Residential	65.2	6.3	14.2	1.2	46.9	6.3
Mixed Forest	328.7	31.7	331.1	28.1	197.5	26.4
Open Water			30.5	2.6		
Other Grasses (Urban/recreation; e.g. parks)	97.2	9.4	6.7	0.6	26.5	3.5
Pasture/Hay	55.6	5.4	161.0	13.7	9.3	1.3
Row Crops	1.8	0.2	6.4	0.6	3.6	0.5
Transitional					0.7	0.1
Total	1,035.9	100.0	1,178.0	100.0	747.9	100.0

APPENDIX B

Water Quality Monitoring Data

There are a number of water quality monitoring stations that provide data for waterbodies identified as impaired for pathogens in the S. Fork Cumberland. The location of these monitoring stations is shown in Figure 5. Monitoring data recorded by TDEC at these stations are tabulated in Table B-1.

Table B-1. TDEC Water Quality Monitoring Data – Pine Creek Subwatersheds

Monitoring Station	Date	E. Coli	Fecal Coliform
		[cts./100 mL]	[cts./100 mL]
LITTO000.2SC	6/15/00	921	630
	6/19/00	1986	2400
	6/21/00	43	100
	6/26/00	100	160
	6/28/00	8360	6500
	7/10/00	20	100
	7/11/00	24810	24000
	7/12/00	1480	1600
	7/17/00	15	100
	7/18/00	50	88
	7/19/00	1730	2800
	1/18/01	84	60
	4/3/01	>2419	1700
NFPIN000.3SC	6/15/00	>2419	5100
	6/19/00	>2419	20000
	6/21/00	921	3000
	6/26/00	1450	3900
	6/28/00	2330	2700
	7/10/00	630	14900
	7/11/00	4220	13900
	7/12/00	520	5600
	7/17/00	630	1400
	7/18/00	300	2300
	7/19/00	57940	23000
	1/18/01	740	2600
	4/3/01	>2419	10000

Table B-1 (Cont.). TDEC Water Quality Monitoring Data – Pine Creek Subwatersheds

Monitoring Station	Date	E. Coli	Fecal Coliform
		[cts./100 mL]	[cts./100 mL]
PINE000.1SC	6/15/00	>2419	32000
	6/19/00	>2419	300
	6/21/00	548	470
	6/26/00	1950	1100
	6/28/00	51720	11400
	7/10/00	520	920
	7/11/00	26020	22000
	7/12/00	2180	2800
	7/17/00	1200	1100
	7/18/00	740	1500
	7/19/00	1830	16000
	1/18/01	10670	13800
	4/3/01	>2419	2200
PINE003.6SC	6/15/00	68	74
	6/19/00	172	200
	6/21/00	41	96
	6/26/00	66	80
	6/28/00	3990	4800
	7/10/00	14	20
	7/11/00	80	60
	7/12/00	2600	2200
	7/17/00	100	63
	7/18/00	310	220
	7/19/00	200	70
	1/18/01	3	10
	4/3/01	197	60
	6/28/04	75	80
	7/1/04	>2419	2600
	7/13/04	28	42
	7/21/04	47	50
	7/28/04	9	88
	8/4/04	79	78
	8/19/04	33	40
	8/25/04	1120	900

Table B-1 (Cont.). TDEC Water Quality Monitoring Data – Pine Creek Subwatersheds

Monitoring Station	Date	E. Coli	Fecal Coliform
		[cts./100 mL]	[cts./100 mL]
PINE003.6SC (continued)	9/1/04	72	56
	9/7/04	30	20
	9/22/04	43	106
	9/29/04	29	36
PINE006.0SC	6/15/00	131	130
	6/19/00	157	180
	6/21/00	29	106
	6/26/00	100	80
	6/28/00	2950	4000
	7/10/00	13	30
	7/11/00	10500	19000
	7/12/00	1220	2400
	7/17/00	28	10
	7/18/00	1710	790
	7/19/00	200	1300
	1/18/01	21	20
	4/3/01	770	600
PINE008.3SC	6/15/00	>2419	3600
	6/19/00	727	1100
	6/21/00	96	100
	6/26/00	300	80
	6/28/00	3500	4200
	7/10/00	840	920
	7/11/00	9090	15200
	7/12/00	630	1400
	7/17/00	48	100
	7/18/00	20	64
	7/19/00	3410	2500
	1/18/01	130	130
	4/3/01	3500	3600
	6/28/04	42	52
	7/1/04	921	940

Table B-1 (Cont.). TDEC Water Quality Monitoring Data – Pine Creek Subwatersheds

Monitoring Station	Date	E. Coli	Fecal Coliform
		[cts./100 mL]	[cts./100 mL]
PINE008.3SC (continued)	7/13/04	57	48
	7/21/04	29	90
	7/28/04	461	500
	8/4/04	88	64
	8/19/04	13	14
	8/25/04	548	1200
	9/1/04	28	30
	9/7/04	69	90
	9/22/04	159	30
	9/29/04	33	30
PINE010.6SC	6/15/00	>2419	4500
	6/19/00	1733	3000
	6/21/00	150	260
	6/26/00	630	420
	6/28/00	7760	7400
	7/10/00	410	30
	7/11/00	13540	18000
	7/12/00	630	1400
	7/17/00	80	58
	7/18/00	93	54
	7/19/00	5460	11000
	1/18/01	261	360
	4/3/01	9870	8000
PINE011.4SC	7/17/00	13	100
	1/18/01	4	10
	4/3/01	35	30
SFPIN000.3SC	6/15/00	328	440
	6/19/00	488	500
	6/21/00	127	122
	6/26/00	410	590
	6/28/00	1750	1700
	7/10/00	93	130
	7/11/00	10810	10000

Table B-1 (Cont.). TDEC Water Quality Monitoring Data – Pine Creek Subwatersheds

Monitoring Station	Date	E. Coli [cts./100 mL]	Fecal Coliform [cts./100 mL]
SFPIN000.3SC	7/12/00	860	460
	7/17/00	43	80
	7/18/00	48	60
	7/19/00	1090	2600
	1/18/01	1210	1100
	4/3/01	1203	2300

APPENDIX C

Load Duration Curve Development and Determination of Required Load Reductions

A flow duration curve is a cumulative frequency graph, constructed from historic flow data at a particular location, that represents the percentage of time a particular flow rate is equaled or exceeded. When a water quality target (or criteria) concentration is applied to the flow duration curve, the resulting load duration curve (LDC) represents the allowable pollutant loading in a waterbody over the entire range of flow. Pollutant monitoring data, plotted on the LDC, provides a visual depiction of stream water quality as well as the frequency and magnitude of any exceedances. Load duration curve intervals can be grouped into several broad categories or zones, in order to provide additional insight about conditions and patterns associated with the impairment. For example, the duration curve could be divided into five zones: high flows (exceeded 0-10% of the time), moist conditions (10-40%), median or mid-range flows (40-60%), dry conditions (60-90%), and low flows (90-100%). Impairments observed in the low flow zone typically indicate the influence of point sources, while those further left on the LDC (representing zones of higher flow) generally reflect potential nonpoint source contributions (Stiles, 2003).

C.1 Development of Flow Duration Curves

Flow duration curves are developed for a waterbody from daily discharges of flow over a period of record. In general, there is a higher level of confidence that curves derived from data over a long period of record correctly represent the entire range of flow. The preferred method of flow duration curve computation uses daily mean data from USGS continuous-record stations located on the waterbody of interest. For ungaged streams, alternative methods must be used to estimate daily mean flow. These include: 1) regression equations (using drainage area as the independent variable) developed from continuous record stations in the same ecoregion; 2) drainage area extrapolation of data from a nearby continuous-record station of similar size and topography; and 3) calculation of daily mean flow using a dynamic computer model, such as the Loading Simulation Program C++ (LSPC).

Flow duration curves for impaired waterbodies in the South Fork Cumberland were derived from LSPC hydrologic simulations based on parameters derived from calibration at USGS Station No. 03408500, located on New River at New River, Tennessee, in the South Fork Cumberland (see Appendix D for details of calibration). For example, a flow-duration curve for Pine Creek at RM 0.1 was constructed using simulated daily mean flow for the period from 10/1/94 through 9/31/04 (RM 0.1 corresponds to the location of monitoring station PINE000.1SC). This flow duration curve is shown in Figure C-4 and represents the cumulative distribution of daily discharges arranged to show percentage of time specific flows were exceeded during the period of record (the highest daily mean flow during this period is exceeded 0% of the time and the lowest daily mean flow is equaled or exceeded 100% of the time). Flow duration curves for other impaired waterbodies were derived using a similar procedure and are shown in Figures C-1 thru C-6.

C.2 Development of Load Duration Curves and Determination of Required Load Reductions

E. coli load duration curves for impaired waterbodies in the South Fork Cumberland were developed from the flow duration curves developed in Section C.1 and available water quality monitoring data. Load duration curves were developed using the following procedure (Pine Creek is shown as an example):

1. A target load-duration curve was generated for Pine Creek by applying the E. coli target concentration of 847 cts./100 mL (941 cts./100mL - MOS) to each of the ranked flows used to generate the flow duration curve (ref.: Section D.1) and plotting the results. The E. coli target maximum load corresponding to each ranked daily mean flow is:

   $(\text{Target Load})_{\text{Pine Creek}}$ = (847 cts./100 mL) x (Q) x (UCF)

   where: Q = daily mean flow
   UCF = the required unit conversion factor

2. Daily loads were calculated for each of the water quality samples collected at monitoring station PINE000.1SC (ref.: Table B-1) by multiplying the sample concentration by the daily mean flow for the sampling date and the required unit conversion factor. PINE000.1SC was selected for LDC analysis because it was the monitoring station on Pine Creek with the most exceedances of the target concentration.

   Note: In order to be consistent for all analyses, the derived daily mean flow was used to compute sampling data loads, even if measured ("instantaneous") flow data was available for some sampling dates.

3. Using the flow duration curves developed in C.1, the "percent of days the flow was exceeded" (PDFE) was determined for each sampling event. Each sample load was then plotted on the load duration curves developed in Step 1 according to the PDFE. The resulting E. coli load duration curve for Pine Creek is shown in Figure C-10.

4. For cases where the existing load exceeded the target maximum load at a particular PDFE, the reduction required to reduce the sample load to the target load was calculated.

5. The 90^{th} percentile value for all of the E. coli sampling data at PINE000.1SC monitoring site was determined. If the 90^{th} percentile value exceeded the target maximum E. coli concentration, the reduction required to reduce the 90^{th} percentile value to the target maximum concentration was calculated.

6. For cases where five or more samples were collected over a period of not more than 30 consecutive days, the geometric mean E. coli concentration was determined and compared to the target geometric mean E. coli coliform concentration of 113 cts/100 mL (126 cts/100mL – MOS). If the sample geometric mean exceeded the target geometric mean concentration, the reduction required to reduce the sample geometric mean value to the target geometric mean concentration was calculated.

7. The load reductions required to meet the target maximum and target 30-day geometric mean concentrations of E. coli were compared and the load reduction of the greatest magnitude selected as the TMDL for Pine Creek. The determination of required load reductions for Pine Creek is shown in Table C-4.

Load reduction curves and required load reductions of other impaired waterbodies were derived in a similar manner and are shown in Figures C-7 through C-12 and Tables C-1 through C-8.

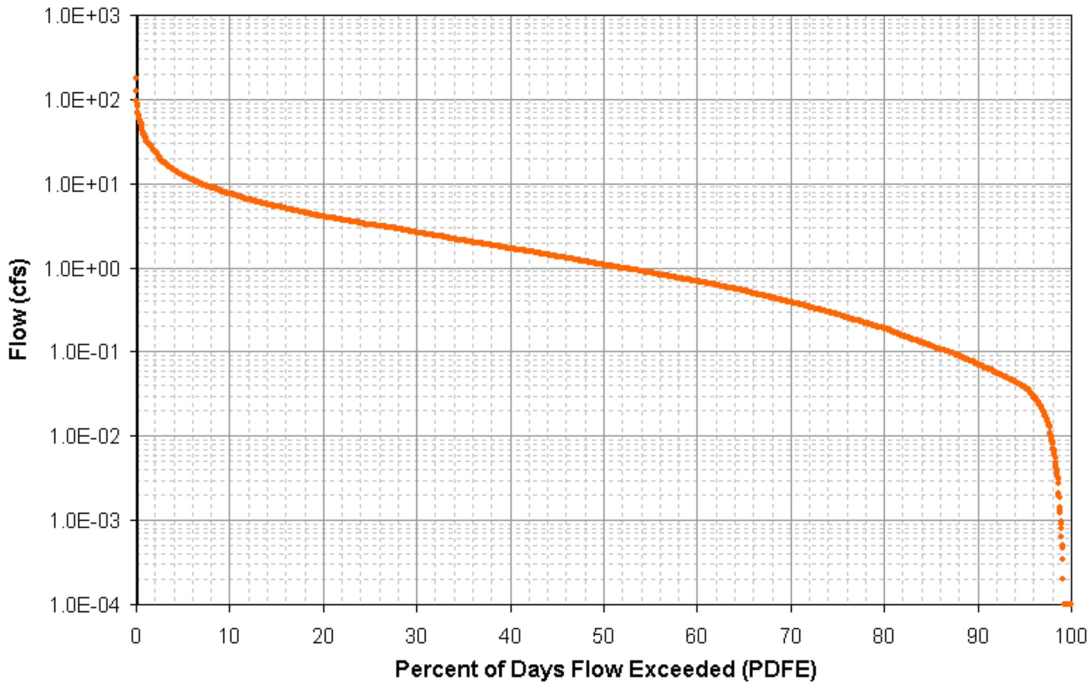

Figure C-1. Flow Duration Curve for North Fork Pine Creek

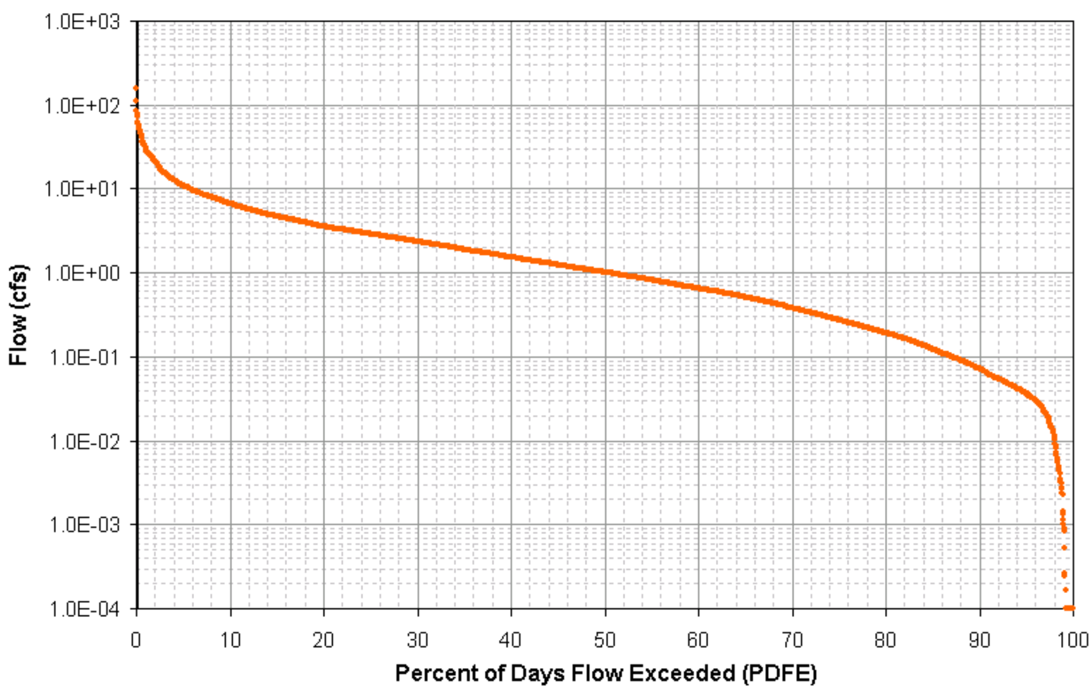

Figure C-2. Flow Duration Curve for Litton Fork Pine Creek

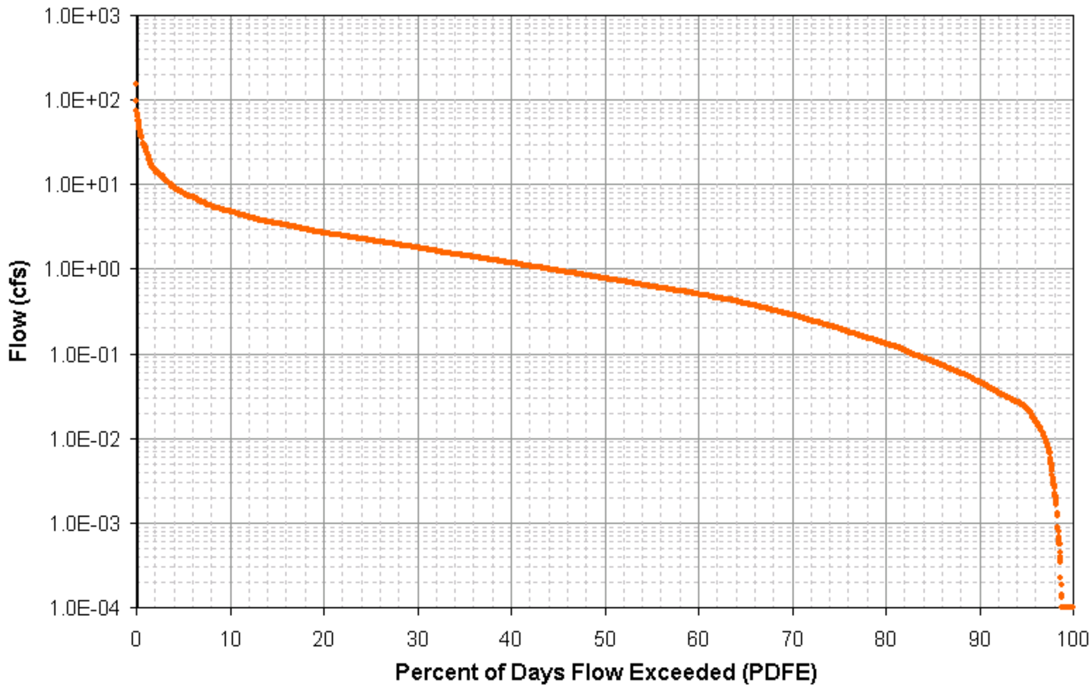

Figure C-3. Flow Duration Curve for South Fork Pine Creek

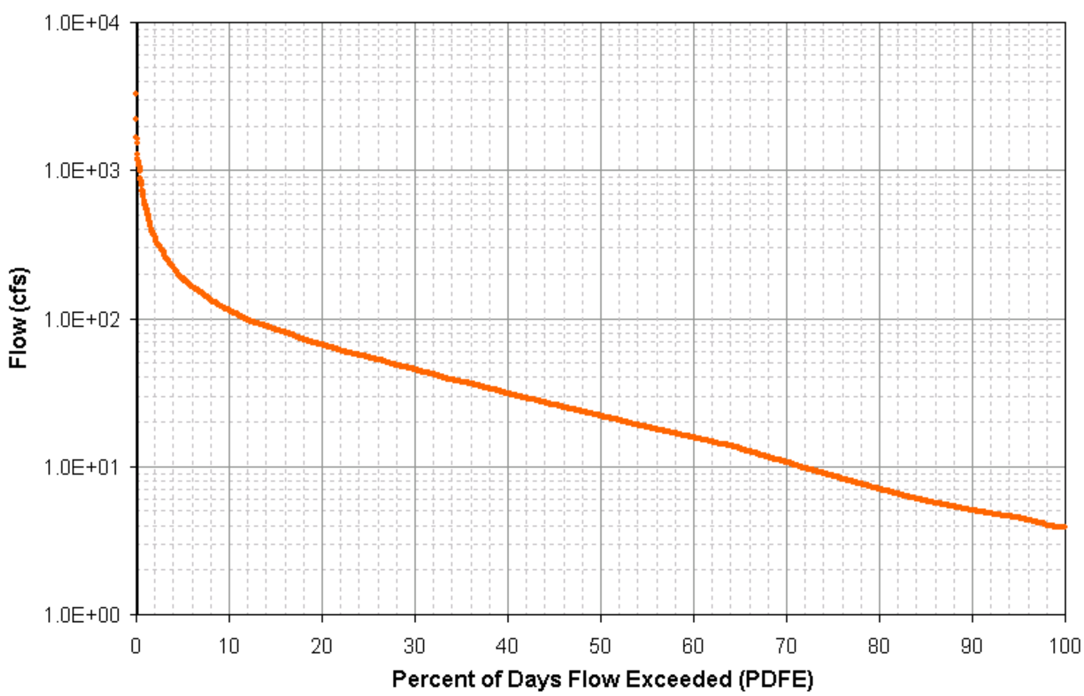

Figure C-4. Flow Duration Curve for Pine Creek at Mile 0.1

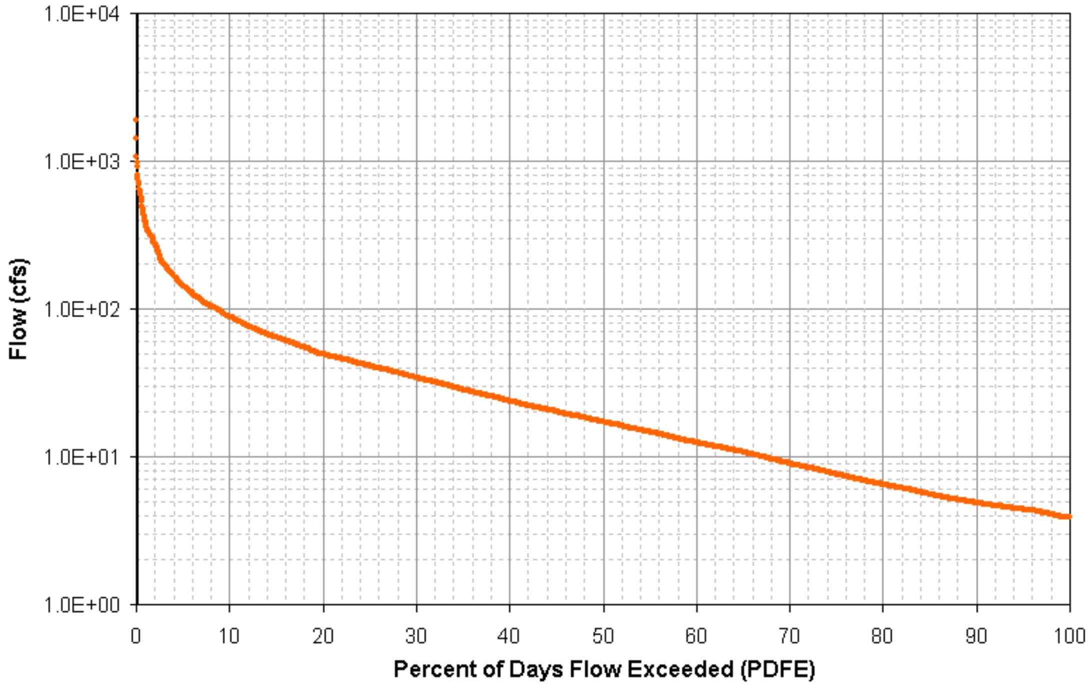

Figure C-5. Flow Duration Curve for Pine Creek at Mile 3.6

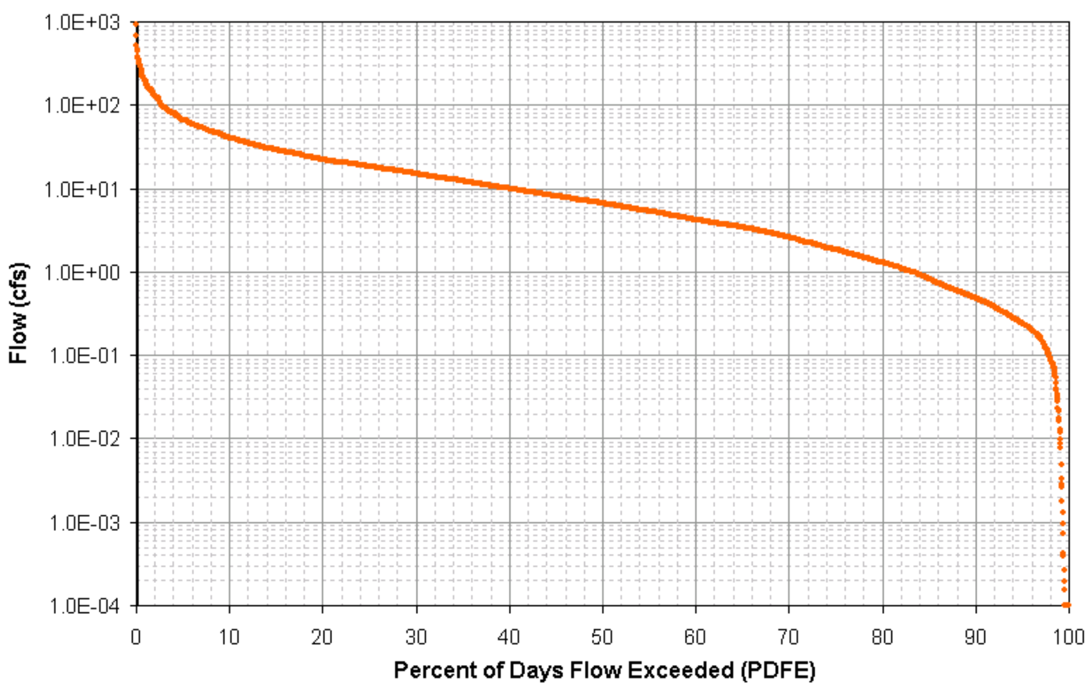

Figure C-6. Flow Duration Curve for Pine Creek at Mile 8.3

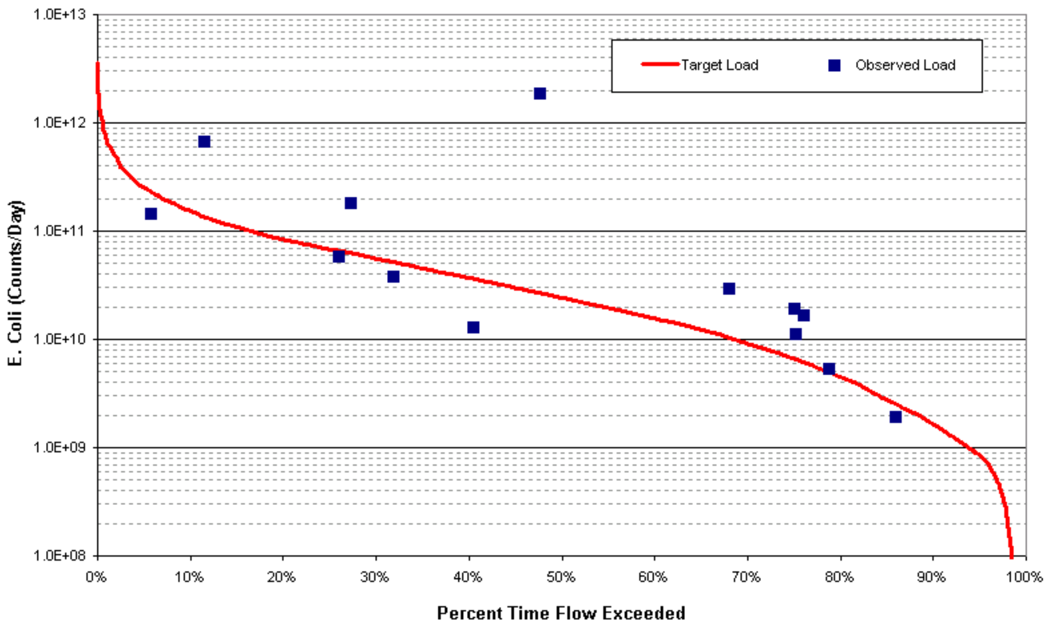

Figure C-7. E. Coli Load Duration Curve for North Fork Pine Creek

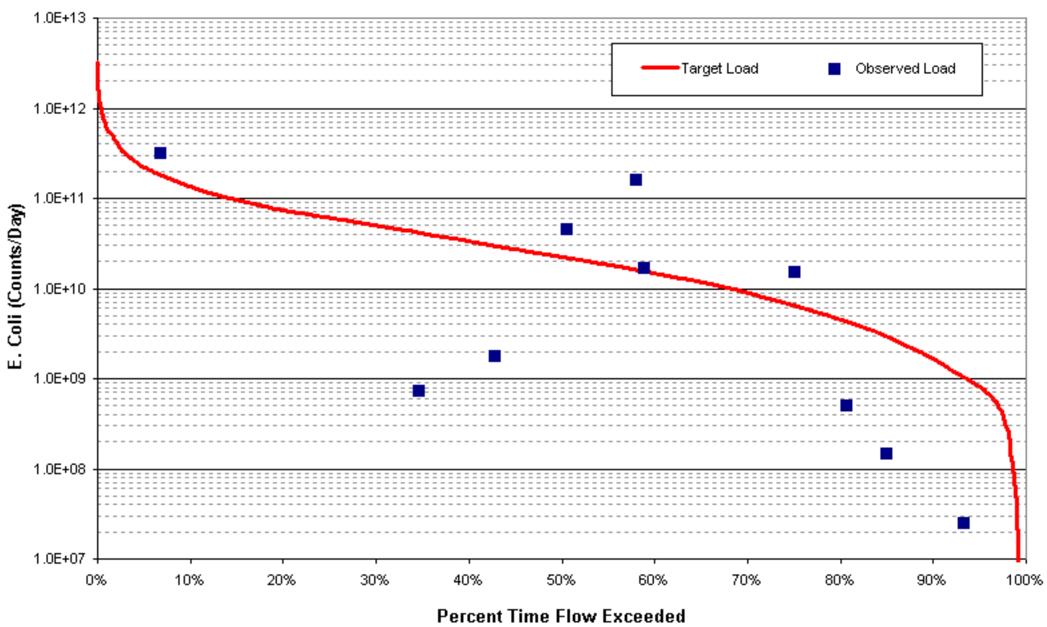

Figure C-8. E. Coli Load Duration Curve for Litton Fork Pine Creek

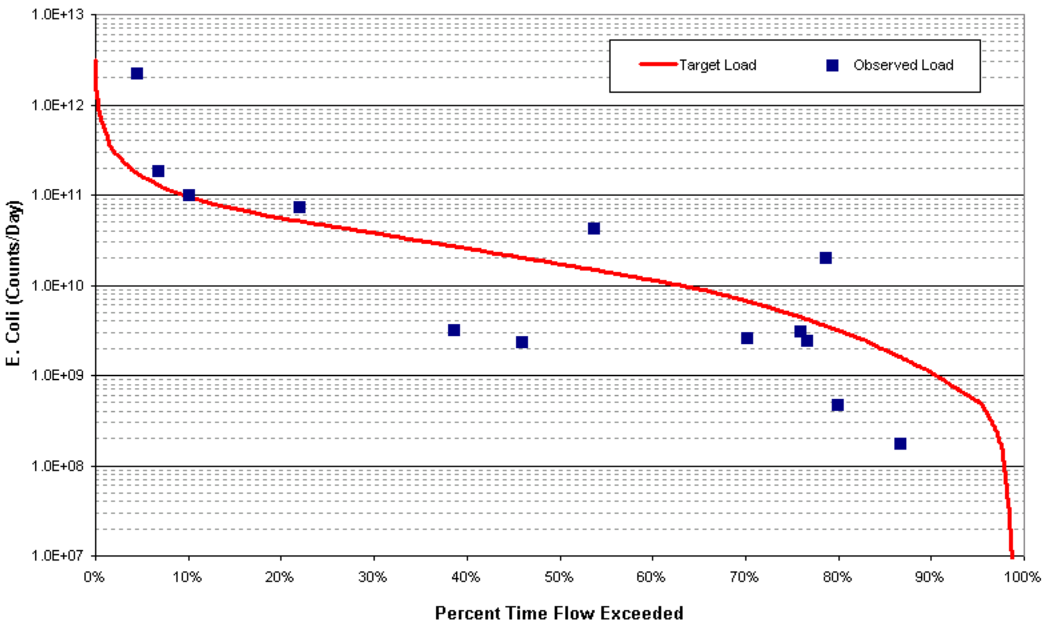

Figure C-9. E. Coli Load Duration Curve for South Fork Pine Creek

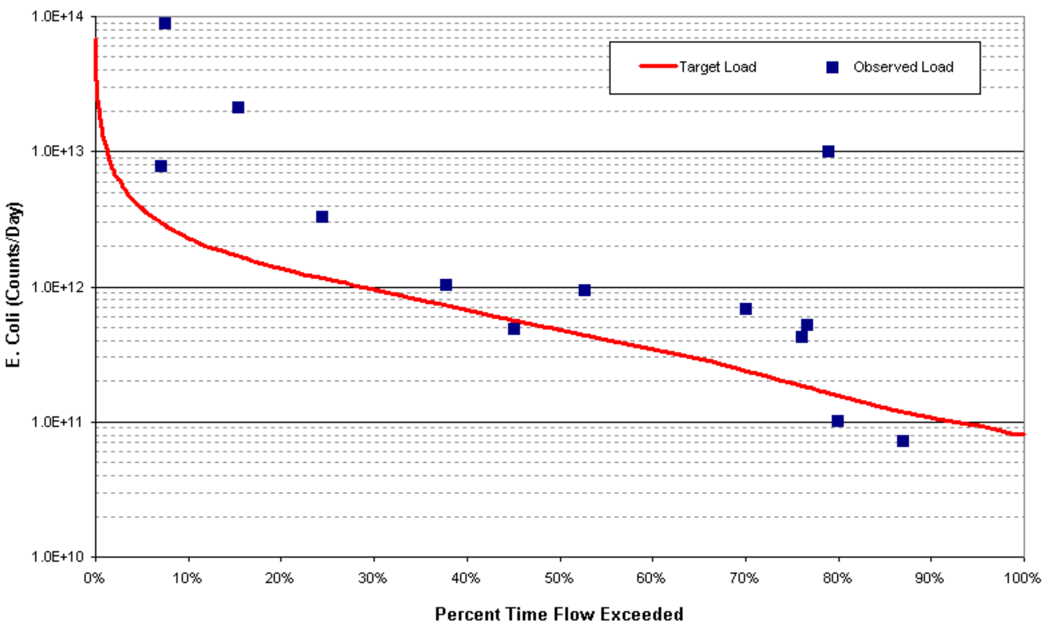

Figure C-10. E. Coli Load Duration Curve for Pine Creek at Mile 0.1

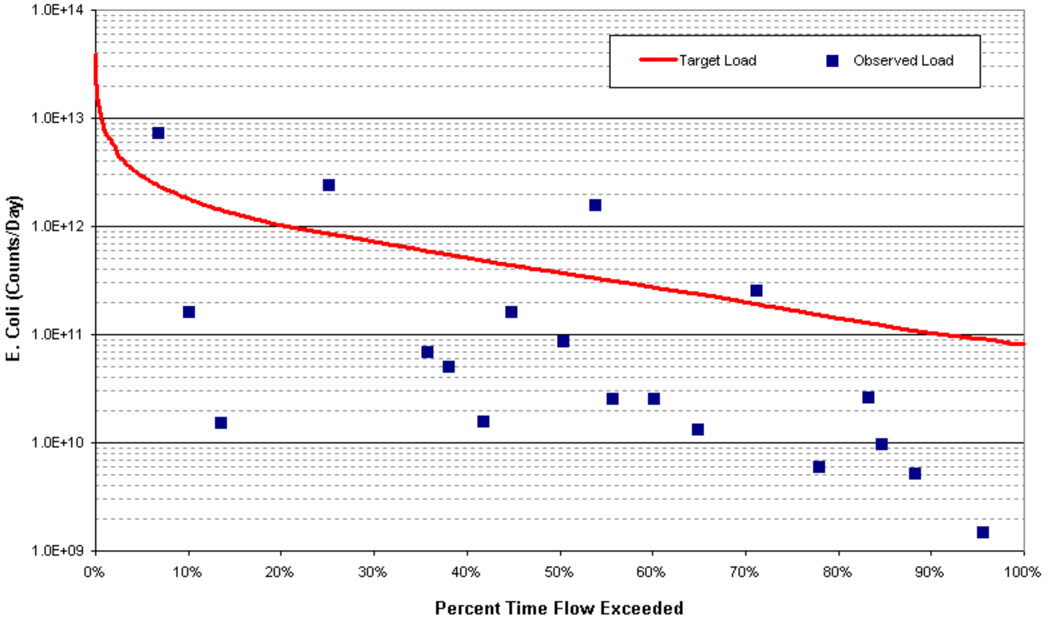

Figure C-11. E. Coli Load Duration Curve for Pine Creek at Mile 3.6

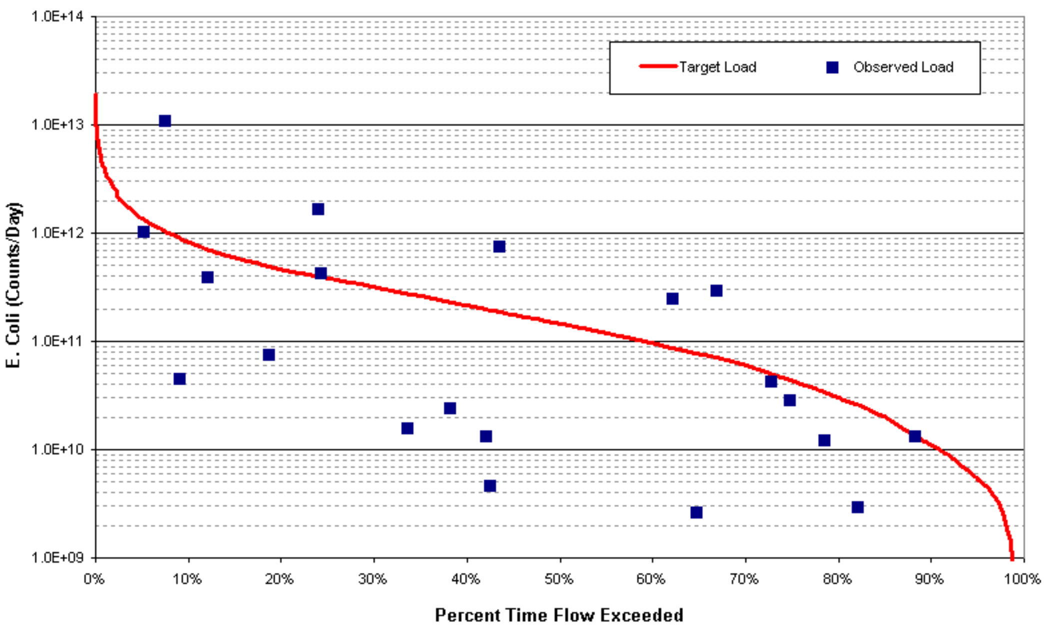

Figure C-12. E. Coli Load Duration Curve for Pine Creek at Mile 8.3

Table C-1. Required Load Reduction for North Fork Pine Creek – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/15/00	0.50	68.0%	>2419	>65.0		
6/19/00	0.32	75.0%	>2419	>65.0		
6/21/00	0.24	78.8%	921	**NR**		
6/26/00	0.32	75.2%	1450	41.6		
6/28/00	0.30	76.1%	2330	63.6	1786.70	**93.7**
7/10/00	0.12	86.0%	630	**NR**		
7/11/00	6.49	11.5%	4220	79.9		
7/12/00	11.22	5.8%	520	**NR**		
7/17/00	2.50	31.9%	630	**NR**		
7/18/00	1.77	40.4%	300	**NR**		
7/19/00	1.30	47.6%	57940	98.5	1572.83	92.8
1/18/01	3.18	26.0%	740	**NR**		
4/3/01	3.04	27.2%	>2419	>65.0		
		90th Percentile	**>3860**	**>78.1**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-2. Required Load Reduction for Litton Fork Pine Creek – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/15/00	0.55	65.8%	921	**NR**		
6/19/00	0.32	74.6%	1986	57.4		
6/21/00	0.21	80.7%	43	**NR**		
6/26/00	0.28	76.9%	100	**NR**		
6/28/00	0.40	71.4%	8360	89.9	580.21	**80.5**
7/10/00	0.11	87.6%	20	**NR**		
7/11/00	6.94	9.3%	24810	96.6		
7/12/00	10.24	5.5%	1480	42.8		
7/17/00	2.21	32.3%	15	**NR**		
7/18/00	1.56	40.7%	50	**NR**		
7/19/00	1.28	45.7%	1730	51.0	313.69	64.0
1/18/01	3.18	23.0%	84	**NR**		
4/3/01	2.89	25.5%	>2419	>65.0		
		90th Percentile	**>7172**	**>88.2**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-3. Required Load Reduction for South Fork Pine Creek – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/15/00	0.32	70.1%	328	**NR**		
6/19/00	0.20	76.6%	488	**NR**		
6/21/00	0.15	79.9%	127	**NR**		
6/26/00	0.21	75.9%	590	**NR**		
6/28/00	0.17	78.6%	4700	82.0	562.61	**79.9**
7/10/00	0.08	86.7%	93	**NR**		
7/11/00	8.45	4.5%	10810	92.2		
7/12/00	4.71	10.0%	860	**NR**		
7/17/00	1.31	38.6%	100	**NR**		
7/18/00	0.97	45.9%	100	**NR**		
7/19/00	0.72	53.6%	>2419	>65.0	524.90	78.5
1/18/01	6.24	6.8%	1210	30.0		
4/3/01	2.49	22.0%	1203	29.6		
		90th Percentile	**>4244**	**>80.0**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-4. Required Load Reduction for Pine Creek at Mile 0.1 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/15/00	11.49	70.0%	>2419	>65.0		
6/19/00	8.76	76.6%	>2419	>65.0		
6/21/00	7.58	79.9%	548	**NR**		
6/26/00	8.97	76.0%	1950	56.6		
6/28/00	7.95	78.9%	51720	98.4	3176.50	**96.4**
7/10/00	5.74	86.9%	520	**NR**		
7/11/00	139.99	7.4%	26020	96.7		
7/12/00	145.32	7.1%	2180	61.1		
7/17/00	35.15	37.8%	1200	29.4		
7/18/00	27.07	45.1%	740	**NR**		
7/19/00	21.24	52.6%	1830	53.7	1905.92	94.1
1/18/01	81.55	15.4%	10670	92.1		
4/3/01	56.13	24.4%	>2419	>65.0		
		90th Percentile	**>22,950**	**>96.3**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-5. Required Load Reduction for Pine Creek – Mile 3.6 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/15/00	11.26	65.4%	68	**NR**		
6/19/00	8.38	74.2%	172	**NR**		
6/21/00	6.57	81.2%	41	**NR**		
6/26/00	7.42	77.7%	66	**NR**		
6/28/00	9.36	70.8%	3990	78.8	166.06	**32.0**
7/10/00	5.28	88.0%	14	**NR**		
7/11/00	85.59	10.3%	80	**NR**		
7/12/00	139.31	5.2%	2600	67.4		
7/17/00	32.13	32.4%	100	**NR**		
7/18/00	23.86	41.1%	310	**NR**		
7/19/00	21.14	44.8%	200	**NR**	161.97	30.2
1/18/01	42.94	24.0%	3	**NR**		
4/3/01	40.18	25.9%	197	**NR**		
6/28/04	96.82	8.8%	75	**NR**		
7/1/04	44.47	23.0%	>2419	>65.0		
7/13/04	24.06	40.9%	28	**NR**		
7/21/04	11.92	63.5%	47	**NR**		
7/28/04	77.00	11.6%	9	**NR**	73.16	**NR**
8/4/04	27.60	36.7%	79	**NR**		
8/19/04	7.41	77.8%	33	**NR**		
8/25/04	8.04	75.4%	1120	24.4	142.93	20.9
9/1/04			72	**NR**		
9/7/04			30	**NR**		
9/22/04			43	**NR**		
9/29/04			29	**NR**	40.51	**NR**
		90th Percentile	**>1899**	**>55.4**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-6. Required Load Reduction for Pine Creek at Mile 6.0 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/15/00	7.89	65.4%	131	**NR**		
6/19/00	5.87	74.2%	157	**NR**		
6/21/00	4.61	81.2%	29	**NR**		
6/26/00	5.20	77.7%	100	**NR**		
6/28/00	6.57	70.8%	2950	71.3	177.45	36.3
7/10/00	3.70	88.0%	13	**NR**		
7/11/00	60.02	10.3%	10500	91.9		
7/12/00	97.69	5.2%	1220	30.6		
7/17/00	22.53	32.4%	28	**NR**		
7/18/00	16.73	41.1%	1710	50.5		
7/19/00	14.83	44.8%	200	**NR**	341.81	**66.9**
1/18/01	30.11	24.0%	21	**NR**		
4/3/01	28.18	25.9%	770	**NR**		
		90th Percentile	**2702**	**68.7**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-7. Required Load Reduction for Pine Creek – Mile 8.3 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/15/00	4.18	62.1%	>2419	>65.0		
6/19/00	2.41	72.8%	727	**NR**		
6/21/00	1.26	82.1%	96	**NR**		
6/26/00	1.65	78.5%	300	**NR**		
6/28/00	3.44	66.8%	3500	75.8	707.50	**84.0**
7/10/00	0.64	88.2%	840	**NR**		
7/11/00	49.59	7.5%	9090	90.7		
7/12/00	66.05	5.1%	630	**NR**		
7/17/00	13.27	33.6%	48	**NR**		
7/18/00	9.38	42.4%	20	**NR**		
7/19/00	9.04	43.5%	3410	75.2	500.65	77.4
1/18/01	23.64	18.7%	130	**NR**		
4/3/01	19.38	23.9%	3500	75.8		
6/28/04	43.57	9.1%	42	**NR**		
7/1/04	19.11	24.2%	921	**NR**		
7/13/04	9.55	42.0%	57	**NR**		
7/21/04	3.74	64.7%	29	**NR**		
7/28/04	34.24	12.0%	461	**NR**	162.76	30.6
8/4/04	11.12	38.2%	88	**NR**		
8/19/04	1.64	78.6%	13	**NR**		
8/25/04	2.13	74.7%	548	**NR**	85.59	**NR**
9/1/04			28	**NR**		
9/7/04			69	**NR**		
9/22/04			159	**NR**		
9/29/04			33	**NR**		
		90th Percentile	**>3464**	**>75.6**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

Table C-8. Required Load Reduction for Pine Creek at Mile 10.6 – E. Coli Analysis

Sample Date	Flow	PDFE	E. Coli			
			Sample Concentration	Required Reduction	Geometric Mean[a]	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]	[cts/100 ml]	[%]
6/15/00	2.19	62.1%	>2419	>65.0		
6/19/00	1.27	72.8%	1733	51.1		
6/21/00	0.66	82.1%	150	**NR**		
6/26/00	0.86	78.5%	630	**NR**		
6/28/00	1.81	66.8%	7760	89.1	1251.83	**91.0**
7/10/00	0.34	88.2%	410	**NR**		
7/11/00	26.00	7.5%	13540	93.7		
7/12/00	34.64	5.1%	630	**NR**		
7/17/00	6.96	33.6%	80	**NR**		
7/18/00	4.92	42.4%	93	**NR**		
7/19/00	4.74	43.5%	5460	84.5	722.36	84.4
1/18/01	12.40	18.7%	630	**NR**		
4/3/01	10.16	23.9%	9870	91.4		
		90th Percentile	**>9448**	**>91.0**		

Note: NR = Not Required
[a] Geometric Mean is calculated whenever 5 or more samples are collected over a period of not more than 30 consecutive days.

APPENDIX D

Hydrodynamic Modeling Methodology

HYDRODYNAMIC MODELING METHOD

D.1 Model Selection

The Loading Simulation Program C++ (LSPC) was selected for flow simulation of pathogen-impaired waters in the subwatersheds of the South Fork Cumberland. LSPC is a watershed model capable of performing flow routing through stream reaches. LSPC is a dynamic watershed model based on the Hydrologic Simulation Program - Fortran (HSPF)

D.2 Model Set Up

The South Fork Cumberland was delineated into subwatersheds in order to facilitate model hydrologic calibration. Boundaries were constructed so that subwatershed "pour points" coincided with HUC-12 delineations, impaired waterbodies, and water quality monitoring stations. Watershed delineation was based on the NHD stream coverage and Digital Elevation Model (DEM) data. This discretization facilitates simulation of daily flows at water quality monitoring stations.

Several computer-based tools were utilized to generate input data for the LSPC model. The Watershed Characterization System (WCS), a geographic information system (GIS) tool, was used to display, analyze, and compile available information to support hydrology model simulations for selected subwatersheds. This information includes land use categories, point source dischargers, soil types and characteristics, population data (human and livestock), and stream characteristics.

An important factor influencing model results is the precipitation data contained in the meteorological data files used in these simulations. Weather data from multiple meteorological stations were available for the time period from January 1970 through August 2004. Meteorological data for a selected 11-year period were used for all simulations. The first year of this period was used for model stabilization with simulation data from the subsequent 10-year period (10/1/94 – 9/30/04) used for TMDL analysis.

D.3 Model Calibration

Hydrologic calibration of the watershed model involves comparison of simulated streamflow to historic streamflow data from U. S. Geological Survey (USGS) stream gaging stations for the same period of time. A USGS continuous record station located in the South Fork Cumberland with a sufficiently long and recent historical record was selected as the basis of the hydrology calibration. The USGS station was selected based on similarity of drainage area, Level IV ecoregion, land use, and topography. The calibration involved comparison of simulated and observed hydrographs until statistical stream volumes and flows were within acceptable ranges as reported in the literature (Lumb, et al., 1994).

Initial values for hydrologic variables were taken from an EPA developed default data set. During the calibration process, model parameters were adjusted within reasonable constraints until acceptable agreement was achieved between simulated and observed streamflow. Model parameters adjusted include: evapotranspiration, infiltration, upper and lower zone storage, groundwater storage, recession, losses to the deep groundwater system, and interflow discharge.

The results of the hydrologic calibration for New River at New River, Tennessee, USGS Station 03408500, are shown in Table D-1 and Figures D-1 and D-2.

Table D-1. Hydrologic Calibration Summary: New River (USGS 03408500)

				381.96	sq. m
	Simulation Name:	3408500	**Simulation Period:**		
		New River @ New River	**Watershed Area (ac):**	244456.93	
	Period for Flow Analysis				
	Begin Date:	**07/01/98**	**Baseflow PERCENTILE:**	2.5	
	End Date:	**06/30/04**	*Usually 1%-5%*		
	Total Simulated In-stream Flow:	**130.26**	Total Observed In-stream Flow:	**137.03**	
	Total of highest 10% flows:	**71.67**	Total of Observed highest 10% flows:	**74.48**	
	Total of lowest 50% flows:	**8.23**	Total of Observed Lowest 50% flows:	**7.91**	
	Simulated Summer Flow Volume (months 7-9):	**15.86**	Observed Summer Flow Volume (7-9):	**10.63**	
	Simulated Fall Flow Volume (months 10-12):	**18.27**	Observed Fall Flow Volume (10-12):	**19.77**	
	Simulated Winter Flow Volume (months 1-3):	**60.40**	Observed Winter Flow Volume (1-3):	**65.07**	
	Simulated Spring Flow Volume (months 4-6):	**35.73**	Observed Spring Flow Volume (4-6):	**41.55**	
	Total Simulated Storm Volume:	**128.87**	Total Observed Storm Volume:	**136.42**	
	Simulated Summer Storm Volume (7-9):	**15.52**	Observed Summer Storm Volume (7-9):	**10.48**	
	Errors (Simulated-Observed)		*Recommended Criteria*	Last run	
	Error in total volume:	**-4.94**	10		
	Error in 50% lowest flows:	**4.04**	10		
	Error in 10% highest flows:	**-3.78**	15		
***	Seasonal volume error - Summer:	**49.15**	30		
	Seasonal volume error - Fall:	**-7.63**	30		
	Seasonal volume error - Winter:	**-7.18**	30		
	Seasonal volume error - Spring:	**-14.00**	30		
	Error in storm volumes:	**-5.54**	20		
	Error in summer storm volumes:	**48.04**	50		

Criteria for Median Monthly Flow Comparisons	
Lower Bound (Percentile):	25
Upper Bound (Percentile):	75

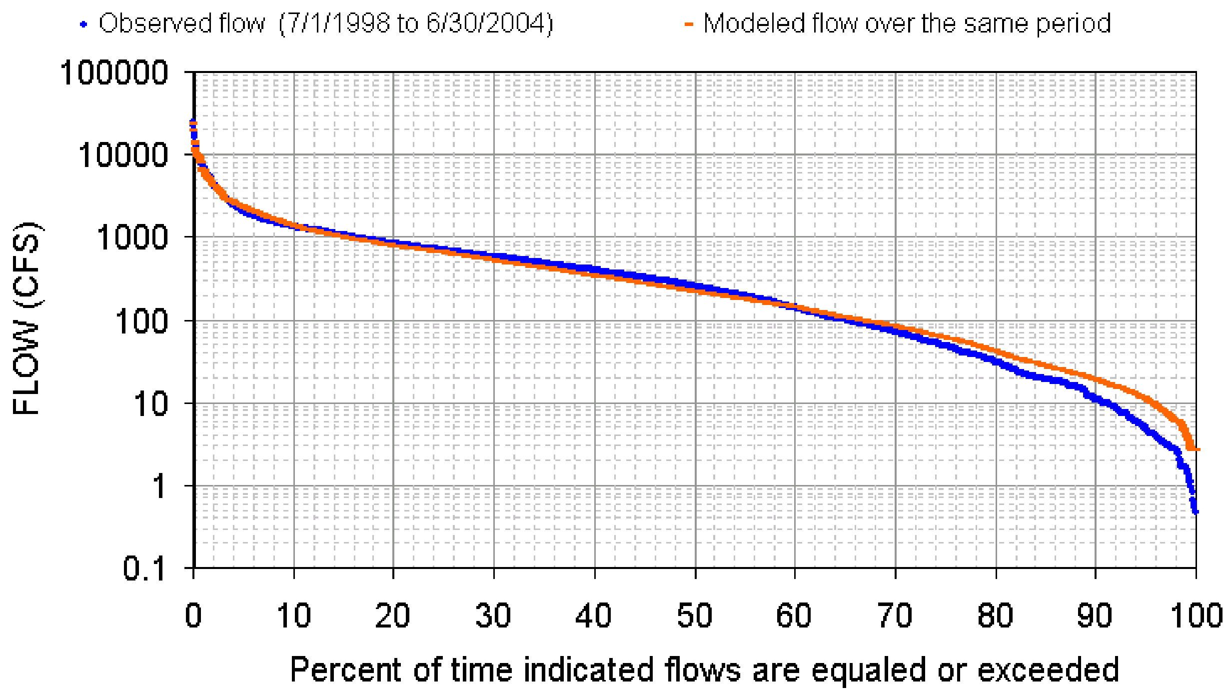

Figure D-1. Hydrologic Calibration: New River, USGS 03408500

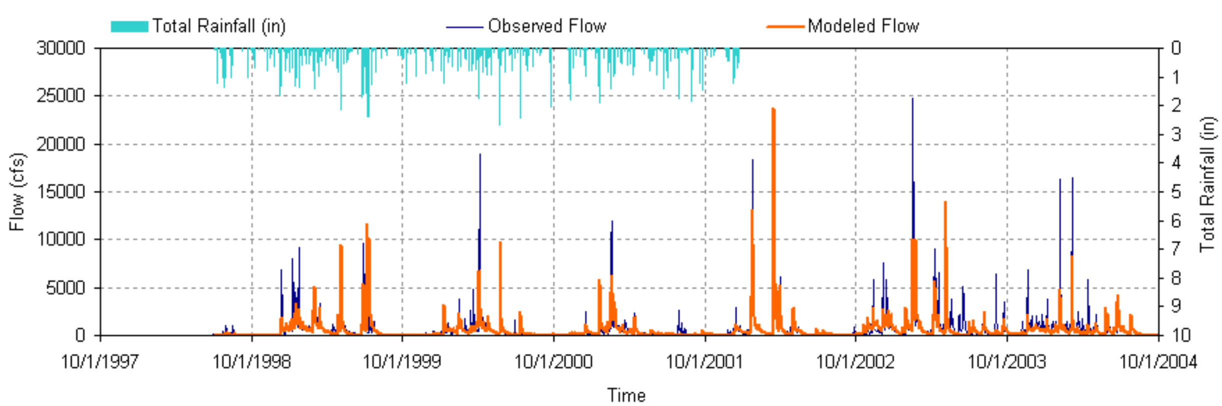

Figure D-2. 7-Year Hydrologic Comparison: New River, USGS 03408500

APPENDIX E

Comparison of Monitoring Data for Two Date Ranges

Table E-1. Required Load Reduction for Pine Creek – Mile 3.6 – Monitoring Data for 2000 – 01

Sample Date	Flow	PDFE	E. Coli	
			Sample Concentration	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/15/00	11.26	65.4%	68	**NR**
6/19/00	8.38	74.2%	172	**NR**
6/21/00	6.57	81.2%	41	**NR**
6/26/00	7.42	77.7%	66	**NR**
6/28/00	9.36	70.8%	3990	78.8
7/10/00	5.28	88.0%	14	**NR**
7/11/00	85.59	10.3%	80	**NR**
7/12/00	139.31	5.2%	2600	67.4
7/17/00	32.13	32.4%	100	**NR**
7/18/00	23.86	41.1%	310	**NR**
7/19/00	21.14	44.8%	200	**NR**
1/18/01	42.94	24.0%	3	**NR**
4/3/01	40.18	25.9%	197	**NR**
90th Percentile			**2142**	**60.5**

Note: NR = Not Required

Table E-2. Required Load Reduction for Pine Creek – Mile 3.6 – Monitoring Data for 2004

Sample Date	Flow	PDFE	E. Coli	
			Sample Concentration	Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/28/04	96.82	8.8%	75	**NR**
7/1/04	44.47	23.0%	>2419	>65.0
7/13/04	24.06	40.9%	28	**NR**
7/21/04	11.92	63.5%	47	**NR**
7/28/04	77.00	11.6%	9	**NR**
8/4/04	27.60	36.7%	79	**NR**
8/19/04	7.41	77.8%	33	**NR**
8/25/04	8.04	75.4%	1120	24.4
9/1/04			72	**NR**
9/7/04			30	**NR**
9/22/04			43	**NR**
9/29/04			29	**NR**
90th Percentile			**1016**	**16.6**

Note: NR = Not Required

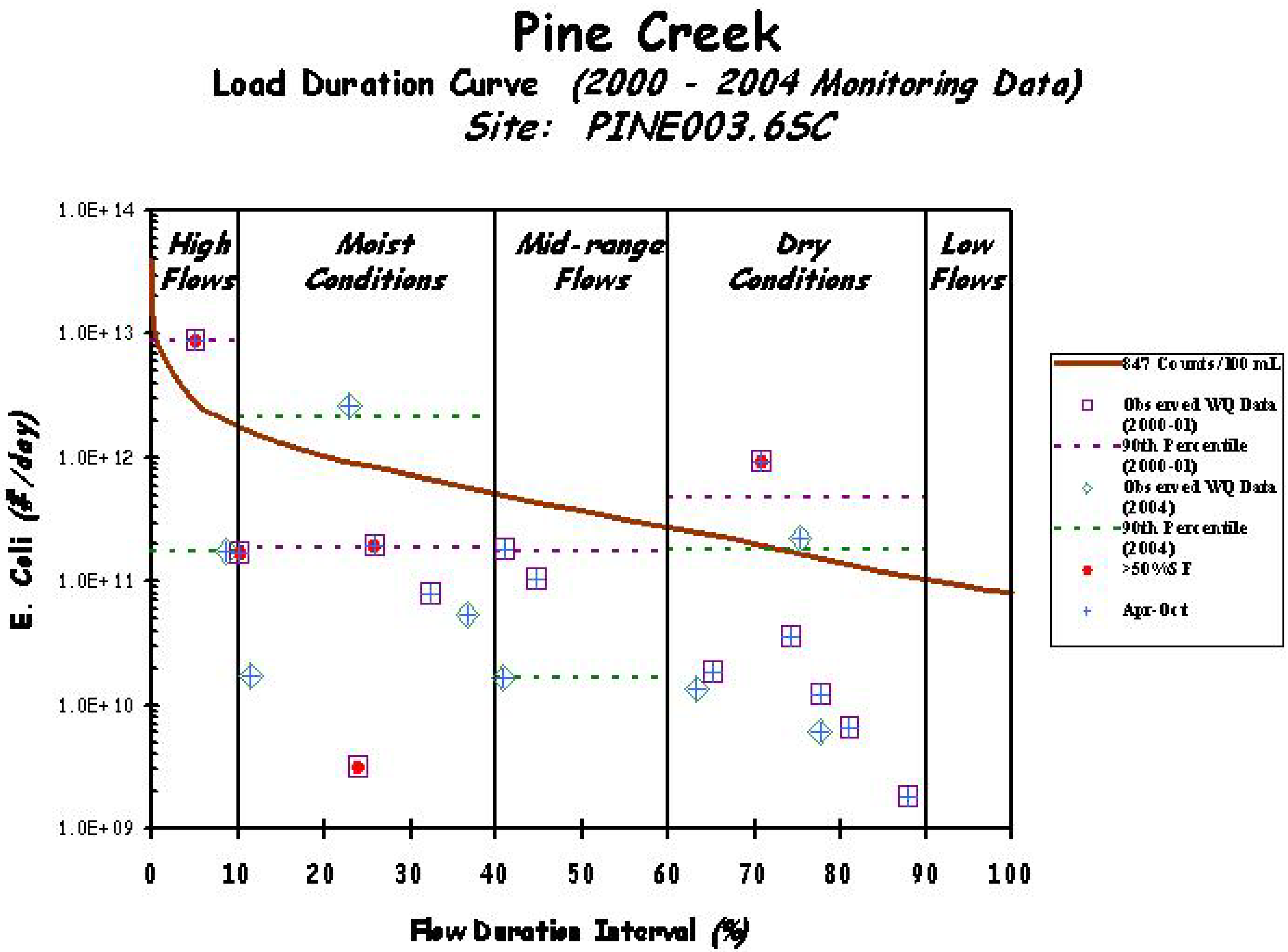

Figure E-1. E. Coli Load Duration Curve for Pine Creek at Mile 3.6

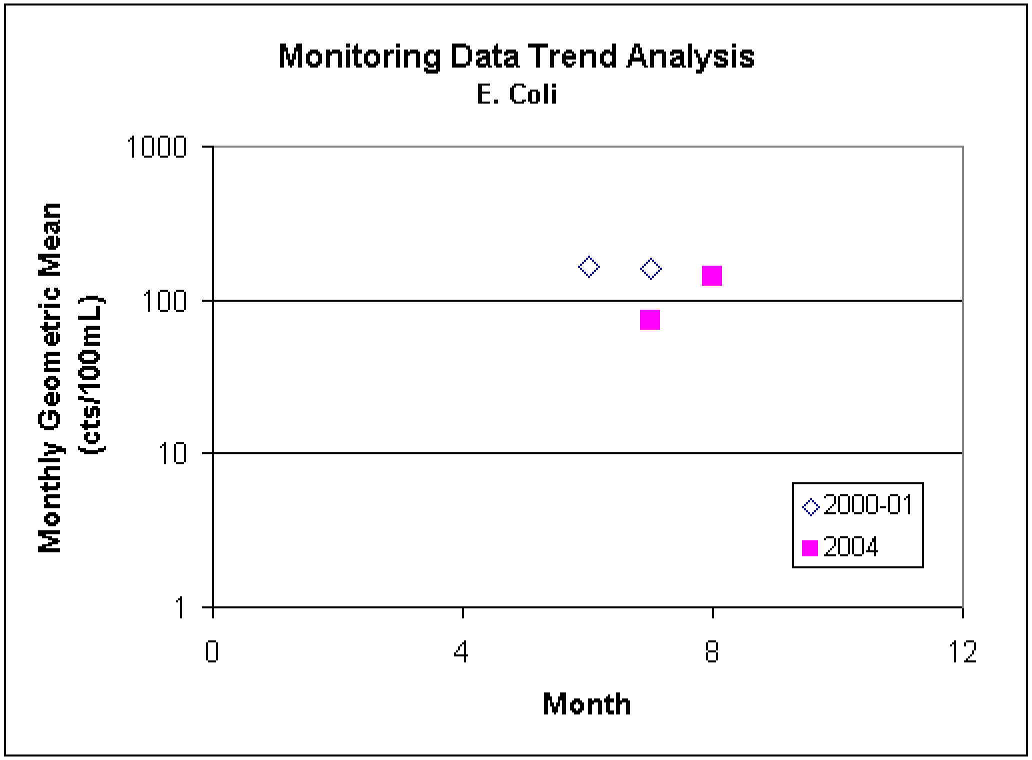

Figure E-2. E. Coli Monitoring Data Trend Analysis for Pine Creek at Mile 3.6

Table E-3. Required Load Reduction for Pine Creek – Mile 8.3 – Monitoring Data for 2000 – 01

Sample Date	Flow	PDFE	E. Coli Sample Concentration	E. Coli Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/15/00	4.18	62.1%	>2419	>65.0
6/19/00	2.41	72.8%	727	**NR**
6/21/00	1.26	82.1%	96	**NR**
6/26/00	1.65	78.5%	300	**NR**
6/28/00	3.44	66.8%	3500	75.8
7/10/00	0.64	88.2%	840	**NR**
7/11/00	49.59	7.5%	9090	90.7
7/12/00	66.05	5.1%	630	**NR**
7/17/00	13.27	33.6%	48	**NR**
7/18/00	9.38	42.4%	20	**NR**
7/19/00	9.04	43.5%	3410	75.2
1/18/01	23.64	18.7%	130	**NR**
4/3/01	19.38	23.9%	3500	75.8
90th Percentile			**3500**	**75.8**

Note: NR = Not Required

Table E-4. Required Load Reduction for Pine Creek – Mile 8.3 – Monitoring Data for 2004

Sample Date	Flow	PDFE	E. Coli Sample Concentration	E. Coli Required Reduction
	[cfs]	[%]	[cts/100 ml]	[%]
6/28/04	43.57	9.1%	42	**NR**
7/1/04	19.11	24.2%	921	**NR**
7/13/04	9.55	42.0%	57	**NR**
7/21/04	3.74	64.7%	29	**NR**
7/28/04	34.24	12.0%	461	**NR**
8/4/04	11.12	38.2%	88	**NR**
8/19/04	1.64	78.6%	13	**NR**
8/25/04	2.13	74.7%	548	**NR**
9/1/04			28	**NR**
9/7/04			69	**NR**
9/22/04			159	**NR**
9/29/04			33	**NR**
90th Percentile			**539**	**NR**

Note: NR = Not Required

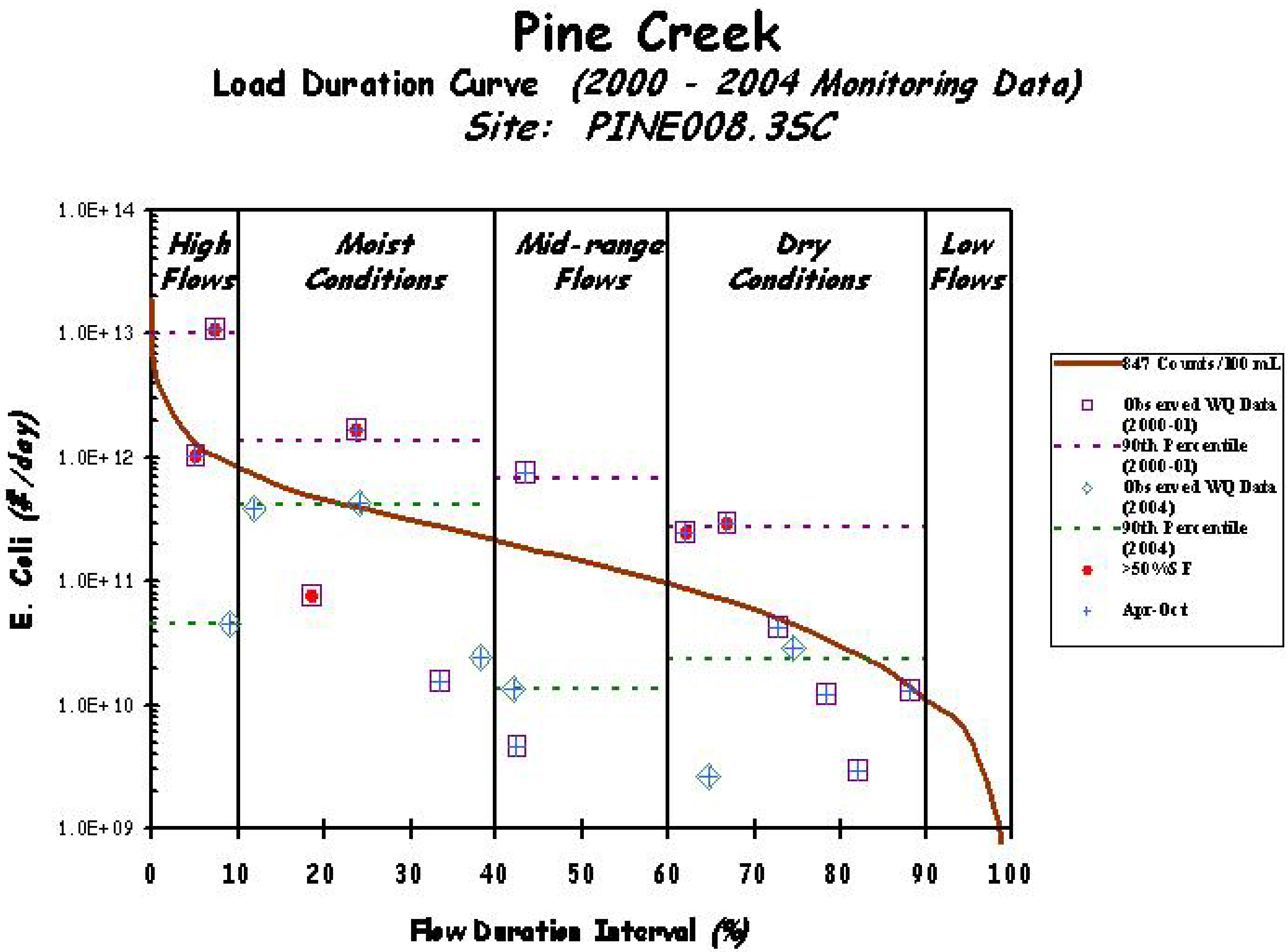

Figure E-3. E. Coli Load Duration Curve for Pine Creek at Mile 8.3

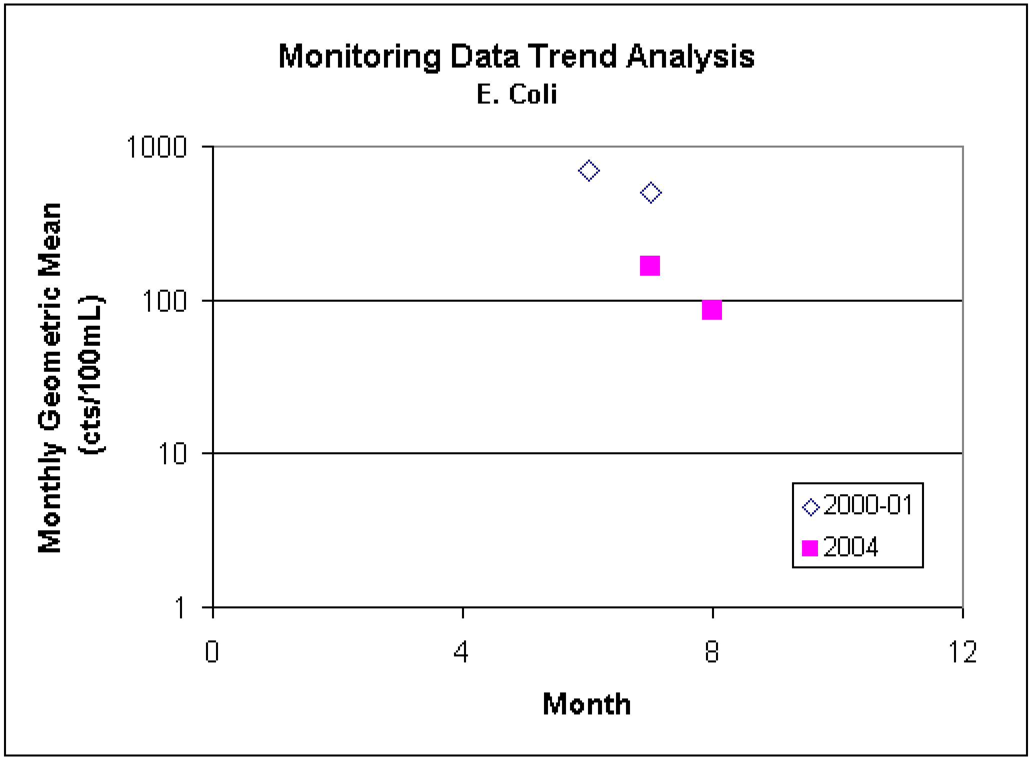

Figure E-4. E. Coli Monitoring Data Trend Analysis for Pine Creek at Mile 8.3

APPENDIX F

Determination of WLAs & LAs

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), nonpoint source loads (Load Allocations), and an appropriate margin of safety (MOS) that takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\text{TMDL} = \Sigma \text{ WLAs} + \Sigma \text{ LAs} + \text{MOS}$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measure.

For pathogen TMDLs in each impaired subwatershed, WLA terms include:

- $[\Sigma \text{WLAs}]_{\text{WWTF}}$ is the allowable load associated with discharges of NPDES permitted WWTFs located in impaired subwatersheds. Since NPDES permits for these facilities specify that treated wastewater must meet instream water quality standards at the point of discharge, no additional load reduction is required. WLAs for WWTFs are calculated from the facility design flow and the Monthly Average permit limit.
- $[\Sigma \text{WLAs}]_{\text{CAFO}}$ is the allowable load for all CAFOs in an impaired subwatershed. All wastewater discharges from a CAFO to waters of the state of Tennessee are prohibited, except when either chronic or catastrophic rainfall events cause an overflow of process wastewater from a facility properly designed, constructed, maintained, and operated to contain:
    - All process wastewater resulting from the operation of the CAFO (such as wash water, parlor water, watering system overflow, etc.); plus,
    - All runoff from a 25-year, 24-hour rainfall event for the existing CAFO or new dairy or cattle CAFOs; or all runoff from a 100-year, 24-hour rainfall event for a new swine or poultry CAFO.

  Therefore, a WLA of zero has been assigned to this class of facilities.
- $[\Sigma \text{WLAs}]_{\text{MS4}}$ is the required load reduction for discharges from MS4s. Fecal coliform and/or E. coli loading from MS4s is the result of buildup/wash-off processes associated with storm events. The percent load reductions for MS4s are considered to be equal to the load reductions developed for TMDLs.

LA terms include:

- $[\Sigma \text{LAs}]_{\text{DS}}$ is the allowable fecal coliform and/or E. coli load from "other direct sources". These sources include leaking septic systems, leaking collection systems, illicit discharges, and animals access to streams. The LA specified for all sources of this type is zero counts/day (or to the maximum extent practicable).
- $[\Sigma \text{LAs}]_{\text{SW}}$ represents the required reduction in fecal coliform and/or E. coli loading from nonpoint sources indirectly going to surface waters from all land use areas (except areas covered by a MS4 permit) as a result of the buildup/wash-off processes

associated with storm events. The percent load reductions for precipitation-induced nonpoint sources are considered to be equal to the load reductions developed for TMDLs (and specified for MS4s).

Explicit MOS has already been incorporated into TMDL development as stated in Appendix C. TMDLs, WLAs, & LAs are applied to the entire subwatershed. WLAs & LAs for Pine Creek waterbodies are summarized in Table F-1.

Table F-1. WLAs & LAs for Pine Creek, Tennessee

HUC-12 Subwatershed (05130104__) or Drainage Area	Impaired Waterbody Name	Impaired Waterbody ID	TMDL	WLAs				LAs	
				WWTFs[a] (Monthly Avg.) E. Coli	Leaking Collection Systems[b]	CAFOs	MS4s[c]	Precipitation Induced Nonpoint Sources	Other Direct Sources[d]
			[% Red.]	[cts./day]	[cts./day]	[cts./day]	[% Red.]	[% Red.]	[cts./day]
0402	North Fork Pine Creek	TN05130104048 – 0200	**97.3**	**NA***	**NA**	**NA**	**NA**	**97.3**	**0**
	Litton Fork Pine Creek	TN05130104048 – 0300	**>88.2**	**NA***	**NA**	**NA**	**NA**	**>88.2**	**0**
	East Fork Pine Creek	TN05130104048 – 0400	**>80.0**	**NA***	**NA**	**NA**	**NA**	**>80.0**	**0**
	Unnamed Trib to Pine Creek	TN05130104048 – 0410							
	South Fork Pine Creek	TN05130104048 – 0500							
	Pine Creek	TN05130104048 – 1000	**96.4**	**4.674×10^9**	**0**	**NA**	**NA**	**96.4**	**0**
	Pine Creek	TN05130104048 – 2000	**75.5**	**4.674×10^9**	**0**	**NA**	**NA**	**75.5**	**0**
	Pine Creek	TN05130104048 – 3000	**91.4**	**NA***	**NA**	**NA**	**NA**	**91.4**	**0**

Note: NA = Not Applicable.
* Future WWTFs must meet instream water quality standards at the point of discharge as specified in their NPDES permit.
a. *WLAs for WWTFs expressed as E. coli loads (counts/day)*
b. *The objective for leaking collection systems is a waste load allocation of zero. It is recognized, however, that a WLA of 0 counts/day may not be practical. For these sources, the WLA is interpreted to mean a reduction in coliform loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.*
c. *Applies to any MS4 discharge loading in the subwatershed.*
d. *The objective for all "other direct sources" is a load allocation of zero. It is recognized, however, that for leaking septic systems a LA of 0 counts/day may not be practical. For these sources, the LA is interpreted to mean a reduction in coliform loading by the application of best management practices, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.*

APPENDIX G

Public Notice Announcement

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER POLLUTION CONTROL

PUBLIC NOTICE OF AVAILABILITY OF PROPOSED TOTAL MAXIMUM DAILY LOAD (TMDL) FOR PATHOGENS IN THE PINE CREEK SUBWATERSHED SOUTH FORK CUMBERLAND WATERSHED (HUC 05130104), TENNESSEE

Announcement is hereby given of the availability of Tennessee's proposed Total Maximum Daily Load (TMDL) for pathogens in the South Fork Cumberland watershed, located in middle Tennessee. Section 303(d) of the Clean Water Act requires states to develop TMDLs for waters on their impaired waters list. TMDLs must determine the allowable pollutant load that the water can assimilate, allocate that load among the various point and nonpoint sources, include a margin of safety, and address seasonality.

A number of waterbodies in the Pine Creek subwatershed are listed on Tennessee's Final 2004 303(d) list as not supporting designated use classifications due, in part, to discharge of pathogens from collection system failure and leaking septic tanks. The TMDL utilizes Tennessee's general water quality criteria, continuous flow data from a USGS discharge monitoring station located in proximity to the watershed, site specific water quality monitoring data, a calibrated hydrologic model, load duration curves, and an appropriate Margin of Safety (MOS) to establish allowable loadings of pathogens which will result in the reduced in-stream concentrations and attainment of water quality standards. The TMDL requires reductions of pathogen loading on the order of 75-97% in the listed waterbodies.

The proposed South Fork Cumberland pathogen TMDL may be downloaded from the Department of Environment and Conservation website:

http://www.state.tn.us/environment/wpc/tmdl/

Technical questions regarding this TMDL should be directed to the following members of the Division of Water Pollution Control staff:

Vicki S. Steed, P.E., Watershed Management Section
Telephone: 615-532-0707

Sherry H. Wang, Ph.D., Watershed Management Section
Telephone: 615-532-0656

Persons wishing to comment on the proposed TMDLs are invited to submit their comments in writing no later than January 16, 2006 to:

Division of Water Pollution Control
Watershed Management Section
7th Floor, L & C Annex
401 Church Street
Nashville, TN 37243-1534

All comments received prior to that date will be considered when revising the TMDL for final submittal to the U.S. Environmental Protection Agency.

The TMDL and supporting information are on file at the Division of Water Pollution Control, 6th Floor, L & C Annex, 401 Church Street, Nashville, Tennessee. They may be inspected during normal office hours. Copies of the information on file are available on request.